From: Henderson, Kim/SDO [Kimberly.Henderson@jacobs.com]
Sent: Thursday, January 3, 2019 4:29 PM
To: Stoick, Paul T CIV NAVFAC SW [paul.stoick@navy.mil]
CC: Hackett, John/DEN [John.Hackett@jacobs.com]
Subject: [Non-DoD Source] RE: Draft Parcel G Work Plan RTCs
Attachments: Final HPNS SAP_redline_010319.docx; Final Parcel G Work Plan_redline_010319.docx; Final Soil RBA Work Plan_redline_010319.docx; Regulator RTCs_Draft Final Parcel G WP_010319.docx

Follow Up Flag: Follow up
Flag Status: Completed

Hi Paul,
Please see the attached updated RTCs and redlined text for the final work plan documents (we plan to have the spelling, editing, and formatting checked after changes and reviews are complete).

As discussed, I also added the sentence regarding 25 samples to the Parcel G Work Plan and SAP with a comment for us to discuss how best to apply this change throughout the text, tables, and figures.

Take a look and let us know if you'd like to discuss.
Thanks!
Kim Henderson, PG, LEED GA
Project Manager
D 1 619 272 7209
(b) (6) [redacted]

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www.jacobs.com

-----Original Message-----
From: Henderson, Kim/SDO
Sent: Wednesday, January 2, 2019 10:36 AM
To: 'Stoick, Paul T CIV NAVFAC SW' <paul.stoick@navy.mil>
Cc: Hackett, John/DEN <John.Hackett@jacobs.com>
Subject: RE: Draft Parcel G Work Plan RTCs

Happy New Year Paul!

Yes, we can send you the redlined final work plan text by the end of this week!

Thanks,
Kim Henderson, PG, LEED GA
Project Manager
D 1 619 272 7209

[redacted]

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www.jacobs.com

-----Original Message-----
From: Stoick, Paul T CIV NAVFAC SW <paul.stoick@navy.mil>
Sent: Wednesday, January 2, 2019 10:12 AM
To: Henderson, Kim/SDO <Kimberly.Henderson@jacobs.com>
Cc: Hackett, John/DEN <John.Hackett@jacobs.com>
Subject: [EXTERNAL] RE: Draft Parcel G Work Plan RTCs

Kim,

Would it be possible to proceed with getting a red-line final WP based on the RTCs for internal Navy review by the end of the week? It would be a red-line change from the Draft Final.

If not the end of this week, could you give me an estimate? We're also trying to figure out how to move forward with the EPA furlough.

Happy New Year!

V/r,
Paul Stoick, P.E.
Environmental Engineer
Remedial Project Manager - Hunters Point ☎ 619-524-6041 | paul.stoick@navy.mil

NAVFAC Southwest - Navy BRAC PMO West
33000 Nixie Way
Bldg 50, 2nd Floor
San Diego, CA 92147

https://bracpmo.navy.mil/ | http://www.navfac.navy.mil/go/erb

-----Original Message-----
From: Stoick, Paul T CIV NAVFAC SW
Sent: Friday, December 28, 2018 10:12 AM
To: 'Henderson, Kim/SDO' <Kimberly.Henderson@jacobs.com>
Cc: Hackett, John/DEN <John.Hackett@jacobs.com>
Subject: RE: Draft Parcel G Work Plan RTCs

Kim,

Attached my comments on the RTCs. I'll be on leave Monday/Tuesday. Let's discuss next year

(Wednesday) when you have a chance. So starts the new year puns. :-)

Thanks!

V/r,
Paul Stoick, P.E.
Environmental Engineer
Remedial Project Manager - Hunters Point ☎ 619-524-6041 | paul.stoick@navy.mil

NAVFAC Southwest - Navy BRAC PMO West
33000 Nixie Way
Bldg 50, 2nd Floor
San Diego, CA 92147

https://bracpmo.navy.mil/ | http://www.navfac.navy.mil/go/erb

-----Original Message-----
From: Henderson, Kim/SDO <Kimberly.Henderson@jacobs.com>
Sent: Thursday, December 20, 2018 4:11 PM
To: Stoick, Paul T CIV NAVFAC SW <paul.stoick@navy.mil>
Cc: Hackett, John/DEN <John.Hackett@jacobs.com>
Subject: [Non-DoD Source] Draft Parcel G Work Plan RTCs

Hi Paul,

Attached are the draft RTCs for the Parcel G work plan comments. Let us know if you need anything else.

Thanks!

Kim Henderson, PG, LEED GA

Project Manager

D 1 619 272 7209

(b) (6) [redacted]

CH2M is now Jacobs.

www.jacobs.com <http://www.jacobs.com/>

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Naval Facilities Engineering Command Southwest
BRAC PMO West
San Diego, CA

Final

Parcel G Removal Site Evaluation Sampling and Analysis Plan

Former Hunters Point Naval Shipyard
San Francisco, California

January 2019

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SAP Worksheet #1—Title and Approval Page

Naval Facilities Engineering Command Southwest
BRAC PMO West
San Diego, CA

Final

Parcel G Removal Site Evaluation Sampling and Analysis Plan

Former Hunters Point Naval Shipyard
San Francisco, California

January 2019

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Approval Signatures

The following person(s) hereby state that they have reviewed this document and approved this document.

Review Signatures:

Anita Dodson 11/12/2018

Anita Dodson/CH2M HILL, Inc. Program Chemist/Date

TRojas 11/12/2018

Theresa Rojas, CQA CQMN/CH2M HILL, Inc. Corporate Quality Assurance Manager/Date

Other Approval Signatures:

____

Joseph Arlauskas/Naval Facilities Engineering Command Southwest Quality Assurance Officer/Date

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Executive Summary

This document presents the Uniform Federal Policy (UFP) Sampling and Analysis Plan (SAP) for the radiological investigation at Parcel G at Hunters Point Naval Shipyard (HPNS), located in San Francisco, California. This document was prepared in accordance with the Department of the Navy's (Navy's) UFP-SAP policy guidance to help ensure that environmental data collected are scientifically sound, of known and documented quality, and suitable for intended uses. The laboratory information cited in this SAP is specific to GEL Laboratories, LLC in Charleston, South Carolina. If additional laboratory services are requested requiring modification to this SAP, revised SAP worksheets will be submitted to the Navy for approval.

Sites that will be addressed under this SAP include former radiologically impacted areas in Parcel G, which occupies 40 acres in the middle of HPNS. Radiological surveys and remediation were previously conducted at HPNS as part of a basewide time-critical removal action (TCRA). Tetra Tech EC, Inc. (TtEC), under contracts with the Navy, conducted a large portion of the basewide TCRA, including Parcel G. Data manipulation and falsification were committed by TtEC employees during the TCRA. An independent third-party evaluation of previous data identified additional potential manipulation and falsification at Parcel G and data quality issues with data collected (Navy, 2017, 2018). As a result, the Navy will conduct investigations at radiologically impacted soil and building sites in Parcel G that were surveyed by TtEC. Future SAPs will address soil and buildings in the other parcels (B, C, D-2, E, UC-1, UC-2, and UC-3), including the North Pier and Ship Berths.

The purpose of the investigation presented in this SAP is to determine whether current site conditions are compliant with the remedial action objective (RAO) in the Parcel G Record of Decision (ROD) (Navy, 2009). The RAO for radiologically impacted soil and structures is to prevent exposure to radionuclides of concern (ROCs) in concentrations that exceed remediation goals (RGs) for potentially complete exposure pathways. Additional reference background areas (RBAs) will also be identified to confirm, or update as necessary, estimates of naturally occurring and man-made background levels for ROCs not attributed to Naval operations at HPNS. A statistical comparison of site data to applicable reference area data will be conducted.

The sampling and analysis activities at Parcel G will be conducted in accordance with this SAP, the separate Parcel G Work Plan, and a separate accident prevention plan/site safety and health plan (APP/SSHP). Project requirements, including personnel roles and responsibilities, required training, and health and safety protocols are based on CH2M HILL, Inc. and its subcontractor, Perma-Fix Environmental Services, leading and conducting the field activities. If another contractor performs the field activities, this SAP will be amended with contractor-specific information, as needed.

Soil Investigations

Soil investigations will be conducted in a phased approach at the following areas in Parcel G:

- Former Sanitary Sewer and Storm Drain Trenches
- Buildings 317/364/365 Former Building Site
- Building 351A Crawl Space

Soil investigation areas will be divided into trench units (TUs) and surface soil survey units (SUs). The size and boundary of the TUs and SUs will be based on previous plans and reports.

Former Sanitary Sewer and Storm Drain Trench Units

For the TUs associated with former sanitary sewers and storm drains (from 1 to 22 feet deep), a phased investigation approach was designed based on a proposal by the regulatory agencies to achieve a high level of confidence that the Parcel G ROD RAO has been met for soil. For Phase 1, 100 percent of soil will be re-excavated

and characterized at 33 percent of TUs in Parcel G. Soil sampling and scanning at the remaining 67 percent of TUs will be performed as part of Phase 2 to increase confidence that current site conditions comply with the Parcel G ROD RAO. The Navy will re-excavate 100 percent of Phase 2 TUs if contamination is identified in Phase 1 TUs. For both Phase 1 TUs and Phase 2 TUs, the durable cover (including asphalt, asphalt base course, concrete, gravel, debris, or obstacles) will be removed to expose the target soils.

Phase 1

Phase 1 includes investigation of a targeted group of TUs. Of the 63 former sanitary sewer and storm drain TUs, 21 were selected for the Phase 1 investigation. The targeted TUs were selected based on the highest potential for radiological contamination in light of historical documentation of specific potential upstream sources, spills, or other indicators of potential contamination (NAVSEA, 2004), and signs of potential manipulation or falsification from the soil data evaluation (Navy, 2017). The Phase 1 soil investigation will include collection of systematic soil samples from each TU, gamma scan of 100 percent of soil, and collection of biased soil samples, where necessary, based on the gamma scan measurements.

All of the soil (100 percent) will be excavated to the original TU boundaries, as practicable, and gamma scans of the excavated material will be conducted during Phase 1. Excavated soil will be gamma-scanned by one of two methods. Soil may be laid out on Radiological Screening Yard pads for a surface scan, or soil may be processed and scanned using soil segregation technology. Following excavation to the original TU boundaries, additional excavation of approximately 6 inches of the trench sidewalls and floors will be performed to provide ex situ scanning and sampling of the trench sidewalls and floors. The excavated soil from within each trench and the over-excavation will be tracked separately, and global positioning system (GPS) location-correlated results will be collected.

Systematic and biased samples will be collected from the excavated soil from the TUs and within the surrounding soil of the TUs. A minimum of 18 systematic samples will be collected from each excavated soil unit and TU. The soil samples will be analyzed for the applicable ROC analysis by accredited offsite laboratories. Soil sample locations will be surveyed using GPS. If the investigation results collected during the gamma scan surveys and systematic and biased soil samples of the over-excavated material demonstrate exceedances of the RGs and are not attributed to naturally occurring radioactive material (NORM) or anthropogenic background, the material will be segregated for further evaluation, and an in situ investigation and/or remediation of the trench sidewalls and floor will be performed prior to backfill.

Phase 2

At the remaining 42 TUs, 100 percent radiological surface gamma scan of accessible areas and soil sampling will be conducted. Subsurface soil samples will be collected via borings, with a minimum of 18 borings within the trench and 1 boring every 50 linear feet along the sidewalls of the trench. The borings will be advanced beyond the floor boundary of the trench or to the point of refusal. Gamma scans of the core will be conducted. Borehole locations will be surveyed using GPS.

The soil samples will be analyzed for the applicable ROC analysis by accredited offsite laboratories.

Former Building Site and Crawl Space Soil Survey Units

At the 28 surface soil SUs[1] from the Former Buildings 317/364/365 Site and Building 351A Crawl Space, the radiological investigation of soil is based on a proposal by the regulatory agencies and includes the following:

[1] Previously, 32 SUs were investigated at Former Buildings 317/364/365 Site and Building 351A Crawl Space; however, some SU areas overlapped. For the Buildings 317/364/365 Former Building Site, former SU 22 overlaps TU 153 and will be investigated as part of TU 153. For the Building 351A Crawl Space, former SU R, SU S, and SU M, SU N, and SU O and will be investigated as SU M, SU N, and SU O.

- Collection of a minimum of 18 systematic soil samples from each SU
- Gamma scan of 100 percent of the soil
- Collection of biased soil samples, where necessary, based on the gamma scan measurements

For all the surface soil SUs, a surface gamma scan of 100 percent of surface soil will be conducted as walk-over or drive-over surveys. GPS location-correlated results will be collected. Systematic and biased samples will be collected from the surface soil SUs. The soil samples will be analyzed for the applicable ROCs by accredited offsite laboratories. Soil sample locations will be surveyed using GPS.

Reference Background Area

Soil sampling will be conducted in RBAs to establish representative background data sets for comparison and evaluation of soil data collected from HPNS, including Parcel G. Four onsite RBAs, located at HPNS, and one undisturbed offsite RBA are planned for radiological background characterization. Gamma scans of accessible surface areas will be performed within the RBAs to confirm that the areas are free of elevated gamma levels and are suitable for sampling. The background characterization will include surface subsurface soil sampling. Soil samples will be analyzed for ROCs. The data will be compared and evaluated to provide representative RBA data sets with a description to assist in determining applicability for specific projects at HPNS. The data evaluation process is summarized in Appendix C of the Parcel G Work Plan.

Building Investigations

Building investigations will be performed at the following structures in Parcel G:

- Building 351A
- Building 351
- Building 366
- Building 401
- Former Building 408 Concrete Pad
- Building 411
- Building 439

Buildings will be divided into SUs, and the size and boundary of the SUs will be based on the previous plans and reports. Radiological investigations at the buildings will include collection of a minimum of 18 systematic static alpha-beta measurements from each SU; alpha-beta scanning of surfaces; collection of biased static alpha-beta measurement, where necessary, based on the alpha-beta scan measurements; collection of swipe samples to assess removable contamination levels; and collection of material samples as needed to further characterize areas of interest.

Data Evaluation

Data from the radiological investigation will be evaluated to determine whether the site conditions are compliant with the Parcel G ROD RAO. If the residual ROC concentrations are below the RGs in the Parcel G ROD or are shown to be representative of NORM or anthropogenic background, then the site conditions are compliant with the Parcel G ROD RAO. Various methods will be used to determine whether the residual ROC concentrations comply with the Parcel G ROD RAO:

- Each sample and measurement result will be compared to the corresponding RG. If all residual ROC concentrations are less than or equal to the corresponding RG, then site conditions comply with the Parcel G ROD RAO.

- Sample and measurement data will be compared to appropriate RBA data and multiple lines of evidence will be evaluated to determine whether site conditions are consistent with NORM or anthropogenic background. The data evaluation may include, but is not limited to, population-to-population comparisons, use of a maximum likelihood estimate or background threshold value, graphical comparisons, and comparison with regional background levels. If all residual ROC concentrations are determined to be consistent with NORM or anthropogenic background, then site conditions comply with the Parcel G ROD RAO.
- Each radium-226 (^{226}Ra) sample result exceeding both the corresponding RG and the expected range of background will be compared to concentrations of other radionuclides in the uranium natural decay series. If the concentrations of radionuclides in the uranium natural decay are consistent with the assumption of secular equilibrium, then the ^{226}Ra concentration is NORM, and site conditions comply with the Parcel G ROD RAO.

If the investigation results demonstrate that there are no exceedances determined from a point-by-point comparison with the statistically-based[2] RGs at agreed upon statistical confidence levels, or that residual ROC concentrations are NORM or anthropogenic background, then a remedial action completion report (RACR) will be developed. If the investigation results demonstrate exceedances of the RGs determined from a point-by-point comparison with the statsticially-based[2] RGs at agreed upon statistical confidence levels and are not shown to be NORM or anthropogenic background, remediation will be conducted, followed by a RACR. The RACR will describe the results of the investigation, explain remediation performed, compare the distribution of data from the sites with applicable reference area data, and provide a demonstration that site conditions are compliant with the Parcel G ROD RAO through the use of multiple lines of evidence including application of statistical testing with agreed upon statistical confidence levels on the background data.

Organization of the SAP

This SAP consists of 37 worksheets specific to the scope of work for the Parcel G Removal Site Evaluation. Tables are embedded within the worksheets. Figures are presented at the end of the document. The project scoping meeting minutes and responses to comments are included in **Attachment 1**. The field standard operating procedures are provided in **Attachment 2**. Laboratory Department of Defense (DoD) Environmental Laboratory Standard Operating Procures are provided in **Attachment 3**. DoD Environmental Laboratory Accreditation Program accreditation letters are included in **Attachment 4**. The technical systems audit checklist is included in **Attachment 5**.

[2] The RGs are statistically based because they are increments above a statistical background.

Contents

Attachments

Tables

Figures

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Acronyms and Abbreviations

^{40}K	potassium-40
^{60}Co	cobalt-60
^{90}Sr	strontium-90
^{137}Cs	cesium-137
^{208}Tl	thallium-208
^{212}Bi	bismuth-212
^{212}Pb	lead-212
^{214}Bi	bismuth-214
^{214}Pb	lead-214
^{226}Ra	radium-226
^{228}Ac	actinium-228
^{228}Th	thorium-228
^{230}Th	thorium-230
^{232}Th	thorium-232
^{234}Pa	protactinium-234
^{234}Th	thorium-234
^{234}U	uranium-234
^{235}U	uranium-235
^{238}Pu	plutonium-238
^{238}U	uranium-238
^{239}Pu	plutonium-239
^{240}Pu	plutonium-240
^{241}Am	americium
%R	percent recovery
APP	Accident Prevention Plan
ASTM	American Society for Testing and Materials
BEC	BRAC Environmental Coordinator
bgs	below ground surface
BLTL	Business Line Team Leader
BMP	best management practice
BRAC	Base Realignment and Closure
BSC	Background Subtraction Count
BTV	background threshold value
CA	corrective action
CAS	Chemical Abstracts Service
CCV	continuing calibration verification
CDPH	California Department of Public Health
CFR	*Code of Federal Regulations*
CH2M	CH2M HILL, Inc.
CLEAN	Comprehensive Long-Term Environmental Action – Navy
CLP	Contract Laboratory Program
cm^2	square centimeter(s)
cm/s	centimeter(s) per second
CSM	conceptual site model

DoD	Department of Defense
DOT	Department of Transportation
dpm/100 cm^2	disintegration(s) per minute per 100 square centimeters
DQA	Data Quality Assessment
DQI	data quality indicator
DQO	data quality objective
DTSC	California Department of Toxic Substances Control
EDD	electronic data deliverable
ELAP	Environmental Laboratory Accreditation Program
EPM	Environmental Program Manager
ESU	excavated soil unit
ft^2	square feet
FWHM	full width at half maximum
GEL	GEL Laboratories, LLC
GFPC	gas flow proportional counting
GPS	global positioning system
HP	Hunters Point
HRA	Historical Radiological Assessment
HPNS	Hunters Point Naval Shipyard
ICAL	initial calibration
ICALE	initial calibration – efficiency
ICALV	Initial calibration – voltage plateau
ICC	instrument contamination check
ICV	initial calibration verification
IECV	efficiency calibration verification
ID	identification
keV	kiloelectron volt
KW	Kruskal-Wallis
LCL	lower control limit
LCS	laboratory control sample
LLRW	low-level radioactive waste
LRPM	Lead Remedial Project Manager
LWTS	liquid waste transfer system
m^2	square meter(s)
MARLAP	*Multi-Agency Radiological Laboratory Analytical Protocols Manual*
MARSSIM	*Multi-Agency Radiation Survey and Site Investigation Manual*
MB	method blank
MDA	minimum detectable activity
MDC	minimum detectable concentration
MLE	maximum likelihood estimate
MS	matrix spike
MSD	matrix spike duplicate
N/A	not applicable
NAVFAC	Naval Facilities Engineering Command
NAVSEA	Naval Sea Systems Command
Navy	Department of the Navy
NORM	naturally occurring radioactive material

NRC	Nuclear Regulatory Commission
NRDL	Naval Radiological Defense Laboratory
OCII	Office of Community Investment and Infrastructure
ORR	Operational Readiness Review
PARCCS	precision, accuracy, representativeness, completeness, comparability, and sensitivity
pCi/g	picocurie(s) per gram
pCi/L	picocurie(s) per liter
Perma-Fix	Perma-Fix Environmental Services
POC	point of contact
PM	Project Manager
PPE	personal protective equipment
QA	quality assurance
QAO	Quality Assurance Officer
QC	quality control
QL	quantitation limit
QSM	*Quality Systems Manual for Environmental Laboratories*
RACR	remedial action completion report
RASO	Radiological Affairs Support Office
RAO	remedial action objective
RBA	reference background area
RER	relative error ratio
RG	remediation goal
ROC	radionuclide of concern
ROD	record of decision
ROICC	Resident Officer in Charge of Construction
RPD	relative percent difference
RPM	Remedial Project Manager
RSO	Radiation Safety Officer
RSY	radiological screening yard
RTC	Response to Comment
SAP	sampling and analysis plan
SB	subsurface soil
SCM	surface contamination monitor
SFDPH	San Francisco Department of Public Health
SFU	sidewall floor unit
SOP	standard operating procedure
SS	surface soil
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
STC	Senior Technical Consultant
SU	survey unit
TBD	to be determined
TCRA	time-critical removal action
TSA	Technical Systems Audit
TtEC	Tetra Tech EC, Inc.

TU	trench unit
UCL	upper control limit
UFP	Uniform Federal Policy
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
VSP	Visual Sampling Plan
Water Board	California Regional Water Quality Control Board, San Francisco Bay Region

SAP Worksheet #2—SAP Identifying Information

Site Name/Number:	Former Hunters Point Naval Shipyard (HPNS), San Francisco, California
Operable Unit:	Not Applicable (N/A)
Contractor Name:	CH2M HILL, Inc. (CH2M)
Contract Number:	N62470-16-D-9000
Contract Title:	Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan) Parcel G Removal Site Evaluation Work Plan, Former Hunters Point Naval Shipyard
Work Assignment Number:	Contract Task Order Number FZ12

1. This Sampling and Analysis Plan (SAP) was prepared in accordance with Naval Facilities Engineering Command (NAVFAC), Southwest Division Work Instructions and the following guidance documents:
   - *Guidance for Quality Assurance Project Plans* (USEPA, 2002)
   - *Uniform Federal Policy for Quality Assurance Project Plans* (USEPA, 2005)
   - *Guidance on Systematic Planning Using the Data Quality Objectives Process* (USEPA, 2006)
   - *Quality Systems Manual for Environmental Laboratories, Version 5.1 (*DoD*, 2017)*
2. Identify regulatory program:
   - Comprehensive Environmental Response, Compensation, and Liability Act
3. This SAP is a project-specific SAP.
4. List dates of scoping sessions that were held:
   - The Department of the Navy (Navy) Base Realignment and Closure (BRAC) Project Management Office held project kickoff meetings on November 17 and 22, 2016, and a meeting with the regulators, including the United States Environmental Protection Agency (USEPA), California Department of Toxic Substances Control (DTSC), Office of Community Investment and Infrastructure (OCII), San Francisco Department of Public Health (SFDPH), and California Regional Water Quality Control Board, San Francisco Bay Region (Water Board) on December 7, 2016.
   - The Navy assembled a Technical Team (a group of technical experts) that includes representatives from the Navy, USEPA, DTSC, California Department of Public Health (CDPH), and the City of San Francisco The Technical Team conducted an evaluation of previous HPNS data in light of the claims made and is developing an approach for follow-up investigations. The Technical Team meets at least bi-weekly to discuss project updates and review documents. To date, several work plan iterations have been submitted and reviewed. For soil, a phased approach was designed based on a proposal by the regulatory agencies on an initial draft work plan. For buildings, the approach was designed based on regulatory comments on an initial draft work plan to conduct surveys based on the Parcel G Record of Decision (ROD). The approaches for soil and buildings are included in the Draft Parcel G Removal Site Evaluation Work Plan, herein referred to as the Parcel G Work Plan, which has been submitted and is currently in review.
5. List dates and titles of documents that are relevant to the current investigation:
   - Previous site work relevant to the current investigation is summarized in **Table 2-1**. **Worksheet #10** includes a summary of the findings from previous investigations.

SAP Worksheet #2—SAP Identifying Information (continued)

Table 2-1. Previous Site Work

Reference Title	Date	Author
Final Historical Radiological Assessment, Volume II, Use of General Radioactive Materials, 1939-2003	2004	NAVSEA
Basewide Radiological Removal Action, Action Memorandum, HPS, San Francisco, California, Revised Final	2006	TtEC
Basewide Radiological Removal Action, Action Memorandum-Revision 2006, HPNS, San Francisco, California	2006	TtEC
Addendum 1 to the Final Sampling and Analysis Plan for the Base-Wide Sewer Systems (Field Sampling Plan and Quality Assurance Project Plan), Base-wide Storm Drain and Sanitary Sewer Removal, HPS, San Francisco, California	2006	TtEC
Base-wide Radiological Work Plan, HPS, San Francisco, California, Revision 1	2007	TtEC
Project Work Plan, Basewide Storm Drain and Sanitary Sewer Removal, HPNS, San Francisco, California, Revision 3	2008	TtEC
Record of Decision for Parcel G	2009	Department of the Navy
Project Work Plan, Base-wide Storm Drain and Sanitary Sewer Removal, HPS, San Francisco, California, Revision 4	2010	TtEC
Basewide Radiological Management Plan	2012	TtEC
Work Plan, Basewide Radiological Support, HPNS, San Francisco, California	2015	TtEC
Radiological Data Evaluation Findings Report for Parcels B and G Soil	2017	Department of the Navy
Building Data Initial Evaluation Report, Draft	2018	Department of the Navy

Notes:
NAVSEA = Naval Sea Systems Command
TtEC = Tetra Tech EC, Inc.

6. Organizational partners (stakeholders) and connection with lead organization:
    - USEPA – Regulatory Stakeholder
    - California DTSC – Regulatory Stakeholder
    - CDPH – Regulatory Stakeholder
    - California Environmental Protection Agency State Water Resources Control Board – Regulatory Stakeholder
    - City of San Francisco – Future Property Owner
    - Surrounding HPNS Community – Public Stakeholder
7. Lead organization:
    - United States Department of the Navy (Navy) – NAVFAC Southwest, BRAC Program Management Office West
8. If any required SAP elements or required information are not applicable to the project or are provided elsewhere, then note the omitted SAP elements and provide an explanation for their exclusion below:
    - No worksheets are excluded from this SAP.

SAP Worksheet #3—Distribution List

Name of SAP Recipients	Title/Role	Organization	Telephone Number	E-mail Address or Mailing Address
Danielle Janda	Lead Remedial Project Manager (LRPM)	Navy BRAC	(619) 524-6041	danielle.janda@navy.mil
Joe Arlauskas	Quality Assurance Officer (QAO)	NAVFAC Southwest	(619) 532-4125	joseph.arlauskas@navy.mil
George (Patrick) Brooks	Navy Project Supervisor	Navy BRAC	(619) 524-5724	george.brooks@navy.mil
Stephen Banister	Navy Remedial Project Manager (RPM)	Navy BRAC	(619) 524-6040	stephen.banister@navy.mil
Derek Robinson	BRAC Environmental Coordinator (BEC)	Navy BRAC	(619) 524-6026	derek.robinson@navy.mil
Zachary Edwards	Director of Environmental Program Division	NAVSEA Radiological Affairs Support Office (RASO)	(757) 887-7762	zachary.edwards@navy.mil
Matthew Slack	Environmental Program Manager (EPM), Health Physicist	NAVSEA RASO	(757) 887-4212	matthew.slack@navy.mil
Matthew Liscio	EPM, Health Physicist	NAVSEA RASO	(757) 887-4354	matthew.liscio@navy.mil
Lily Lee	RPM, Staff Technical Lead	USEPA	(415) 847-4187	lee.lily@epa.gov
John Chesnutt	Section Manager, U.S. Army, Navy	USEPA	(415) 972-3005	chesnutt.john@epa.gov
Janet Naito	Branch Manager, Cleanup	DTSC	(510) 540-3833	janet.naito@dtsc.ca.gov
Nina Bacey	RPM	DTSC	(510) 540-2480	juanita.bacey@dtsc.ca.gov
Sheetal Singh	Environmental Management Branch	CDPH	(916) 449-5691	sheetal.singh@cdph.ca.gov
Matt Wright	Environmental Management Branch	CDPH	(916) 210-8550	matthew.wright@cdph.ca.gov
Tina Low	RPM/Technical Staff Lead	Water Board	(510) 622-5682	tina.low@waterboards.ca.gov
Amy Brownell	Staff Lead Technical SFDPH	SFDPH	(415) 252-3967	amy.brownell@sfdph.org
Anita Dodson	Program Chemist/SAP Reviewer/QAO	CH2M	(757) 671-6218	anita.dodson@ch2m.com
Janna Staszak	SAP Reviewer	CH2M	(757) 518-9666	janna.staszak@ch2m.com
Kim Henderson	Project Manager (PM)	CH2M	(619) 272-7209	kimberly.henderson@ch2m.com

SAP Worksheet #3—Distribution List (continued)

Name of SAP Recipients	Title/Role	Organization	Telephone Number	
John Hackett	Senior Radiological Technical Consultant	CH2M	(303) 589-7217	Jo
Mark Cichy	Project Chemist	CH2M	(530) 229-3274	m
Loren Kaehn	Health and Safety Manager	CH2M	(208) 383-6212	lo
Kevin Smallwood	Field Team Leader	CH2M	(970) 250-5441	ke
Rachel Zajac-Fay	Site Safety and Health Officer (SSHO)	CH2M	(916) 286-0235	ra
Theresa Rojas	Corporate Quality Assurance Manager	CH2M	(678) 530-4297	th
Scott Hay	Radiological Senior Technical Consultant (STC)	Cabrera	(702) 236-8401	sh
Alex Lopez	Radiological Support PM /License Radiation Safety Officer (RSO)	Perma-Fix Environmental Services (Perma-Fix)	(970) 778-0449	al
Valerie Davis	Analytical Laboratory PM	GEL Laboratories, LLC (GEL)	(843) 556-8171	te
Bob Pullano	Laboratory QAO	GEL	(843) 556-8171	rl
TBD	Data Validation PM	TBD	TBD	TE
TBD	Utility Locator	TBD	TBD	TE
TBD	Driller	TBD	TBD	TE
TBD	Direct-push Technology Provider	TBD	TBD	TE
TBD	Surveyor	TBD	TBD	TE

Notes:

TBD cells will be populated with information after personnel are selected, prior to fieldwork.

SAP Worksheet #4—Project Personnel Sign-off Sheet

Name	Organization/Title/Role	Telephone Number (optional)	Signature/e-mail receipt	SAP Section Reviewed	Date SAP Read
Kim Henderson	CH2M/PM	(619) 272-7209			
John Hackett	CH2M/STC	(303) 589-7217			
Kevin Smallwood	CH2M/Field Team Leader	(970) 250-5441			
Mark Cichy	CH2M/Project Chemist	(530) 229-3274			

Name	Organization/Title/Role	Telephone Number (optional)	Signature/e-mail receipt	SAP Section Reviewed	Date SAP Read
Monica Calabria	CH2M/Data Manager	(610) 399-3860			
Rachel Zajac-Fay	CH2M/SSHO	(916) 286-0235			
Valerie Davis	GEL/Laboratory PM	(843) 556-8171			
TBD	TBD/Data Validation PM	TBD			
TBD	CH2M/Sampling Personnel	TBD			

Notes:

The sampling personnel will read the appropriate sections of this document before performing activities related to this SAP. The completed sign-off worksheet will be maintained in the project file.

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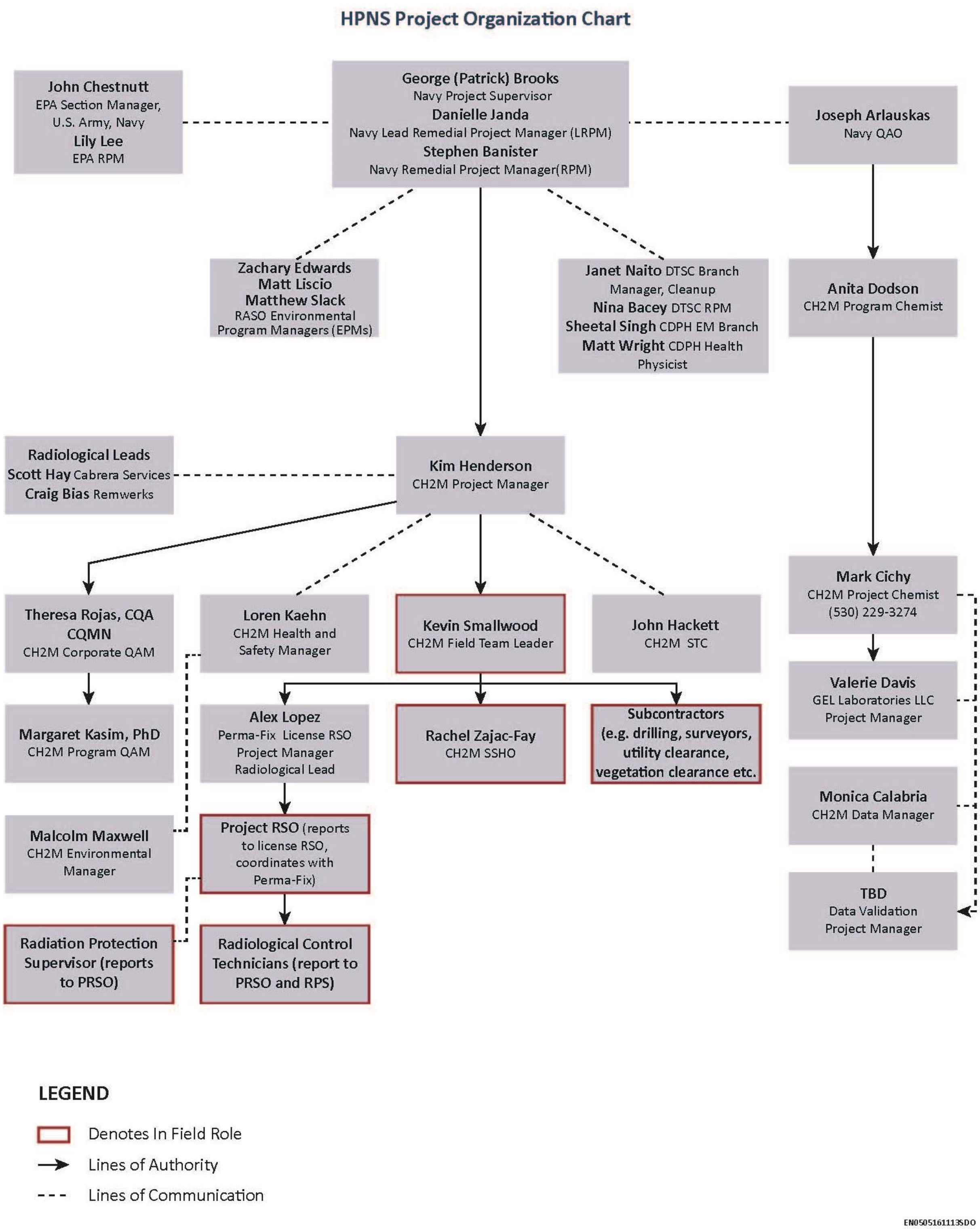
SAP Worksheet #5—Project Organizational Chart[3]



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[3] Project personnel for the Parcel G soil investigation will be updated with an addendum to this SAP.

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SAP Worksheet #6—Communication Pathways

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or e-mail	Procedure (timing, pathway to and from, etc.)
Communication with Navy (lead agency)	Navy LRPM	Danielle Janda	(619) 524-6041	Primary points of contact (POCs) for Navy; can delegate communication to other internal or external POCs. PM will communicate either verbally or by e-mail with earliest schedule possible for fieldwork to commence. Navy will provide PM with written instruction to proceed upon completing coordination with Contracting Officer. Navy will notify USEPA, DTSC, CDPH, and SDPH by e-mail or telephone call for significant field changes effecting the scope or implementation of the design.
	Navy Project Supervisor	George (Patrick) Brooks	(619) 524-5724	
	NAVSEA RASO, Director of Environmental Program Division	Zachary Edwards	(757) 887-7762	
	NAVSEA RASO, EPM, Health Physicist	Matthew Slack	(757) 887-4212	
	NAVSEA RASO, EPM, Health Physicist	Matt Liscio	(757) 887-4354	
Communication with USEPA	USEPA	TBD	TBD	Primary POC for USEPA; can delegate communication to other internal or external POCs. Upon notification of field changes, USEPA will review significant field changes. Reports and other project-related information are submitted by the Navy for review and comments by the agency.
Communication with DTSC	DTSC Branch Manager, Cleanup	Janet Naito	(510) 540-3833	Primary POCs for DTSC; can delegate communication to other internal or external POCs. Upon notification of field changes, DTSC will review significant field changes. Reports and other project-related information are submitted by the Navy for review and comments by the agency.
	DTSC RPM	Nina Bacey	(510) 540-2480	
Communication with Water Board	RPM, Technical Lead Staff	Tina Low	(510) 622-5682	Primary POCs for Water Board; can delegate communication to other internal or external POCs. Upon notification of field changes, Water Board will review significant field changes. Reports and other project-related information are submitted by the Navy for review and comments by the agency.

SAP Worksheet #6—Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or e-mail	Procedure (timing, pathway to and from, etc.)
Communication with SFDPH	SFDPH Staff Lead	Amy Brownell	(415) 252-3967	Primary POCs for SFDPH; can delegate communication to other internal or external POCs. Reports and other project-related information are submitted by the Navy for review and comments by the agency.
Communication regarding overall project status and implementation, and primary POC with Navy, USEPA, DTSC, Water Board, SFDPH	CH2M PM	Kim Henderson	(619) 272-7209	Oversees project and will be informed of project status by the field team. If field changes occur, PM will work with the Navy to communicate in-field changes to the regulatory agencies by e-mail. Materials and information about the project are forwarded to the Navy by the PM.
Communication with the Comprehensive Long-Term Environmental Action – Navy (CLEAN) program	CH2M Deputy Program Manager	Doug Dronfield	(703) 376-5090	Oversees the CLEAN program for CH2M as needed. Will be notified if field changes occur that require program support.
Technical communications for project implementation and data interpretation	CH2M Radiological Lead Cabrera Radiological Lead Perma-Fix Lead PM/RSO	John Hackett Scott Hay Alex Lopez	(303) 589-7217 (702) 236-8401 (970) 778-0449	Contact STC regarding questions/issues encountered in the field, input on data interpretation, as needed. STC will have 24 hours to respond to technical field questions as necessary. Additionally, STC will review the data as necessary during report preparation.
Communications regarding the SAP	CH2M SAP reviewer	Janna Staszak	(757) 671-6256	Changes/revisions to the SAP will be reviewed by the SAP reviewer, as soon as possible, and as necessary.
SAP amendments	CH2M Program Chemist	Anita Dodson	(757) 671-6218	Any changes to the SAP are submitted in writing to the Navy QAO, who must approve the changes prior to implementation. The appropriate regulatory agencies will also be notified when SAP amendments are issued.

SAP Worksheet #6—Communication Pathways (continued)

<table>
<tr><th>Communication Drivers</th><th>Responsible Affiliation</th><th>Name</th><th>Phone Number and/or e-mail</th><th>Procedure (timing, pathway to and from, etc.)</th></tr>
<tr><td>SAP amendment approvals</td><td>Navy QAO</td><td>Joseph Arlauskas</td><td>(619) 532-4125</td><td>Issues final approval of SAP amendments to Program Chemist via signed approval form (portable document format is acceptable). Concurrence from the Navy LRPM/Business Line Team Leader (BLTL).</td></tr>
<tr><td>Communication with Navy QAO</td><td>CH2M Program Chemist</td><td>Anita Dodson</td><td>(757) 671-6218</td><td>Quality-related materials and information about the project are forwarded to the Navy QAO by the Program Chemist.</td></tr>
<tr><td>Health and safety</td><td>CH2M HSM</td><td>Loren Kaehn</td><td>(208) 383-6212</td><td>Responsible for generation of the Health and Safety Plan and approval of the activity hazard analyses prior to the start of fieldwork. The PM will contact the HSM as needed regarding questions/issues encountered in the field.</td></tr>
<tr><td>Health and safety</td><td>CH2M SSHO</td><td>Rachel Zajac-Fay</td><td>(916) 286-0235</td><td>Responsible for the adherence of team members to the site safety requirements described in the Health and Safety Plan. Will report health and safety incidents to PM as soon as possible.</td></tr>
<tr><td>Field progress reports</td><td>Field Team Leader CH2M</td><td>Kevin Smallwood</td><td>(970) 250-5441</td><td>Daily field progress reports will be prepared by the Field Team Leader and submitted to the PM by phone or e-mail.</td></tr>
<tr><td rowspan="2">Stop work issues</td><td>Field Team Leader CH2M</td><td>Kevin Smallwood</td><td>(970) 250-5441</td><td rowspan="2">Field Team leader notifies PM about any stopped work that occurs. All field personnel have stop work authority based on the Accident Prevention Plan (APP) and Site Safety and Health Plan (SSHP). Joseph Arlauskas, Navy QAO, or representative, has authority to stop work if quality-related compliance issues are identified, or if there is noncompliance with field quality control (QC) protocols, as specified in this SAP.</td></tr>
<tr><td>Navy QAO</td><td>Joseph Arlauskas</td><td>(619) 532-4125</td></tr>
</table>

SAP Worksheet #6—Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or e-mail	Procedure (timing, pathway to and from, etc.)
Revising sampling program (adding or removing sampling location or revising analytical suite)	CH2M PM	Kim Henderson	(619) 272-7209	Changes to the sampling program are submitted in writing as a field change request or proposed SAP amendment to the Navy QAO, who must approve the changes prior to implementation.
Field deviations from the SAP	Field Team Leader	Kevin Smallwood	(970) 250-5441	Documentation of deviations from the SAP will be made in the field logbook, and the PM will be notified immediately. Deviations will be made only with approval from the PM. The appropriate regulatory agencies will also be notified of significant field deviations from the SAP as appropriate.
Release of field data	Field Team Leader CH2M	Kevin Smallwood	(970) 250-5441	Field data are reviewed by the Field Team Leader and are transmitted by e-mail or hard copy shipping to the PM.
Reporting analytical data quality issues	GEL PM	Valerie Davis	(843) 556-8171	Quality assurance (QA)/QC issues with project field samples will be reported within 2 days to the Project Chemist by the laboratory.
Field or analytical corrective actions (CAs)	Program Chemist CH2M	Anita Dodson	(757) 671-6218	CAs for field and analytical issues will be determined by the Field Team Leader and/or the Project Chemist and reported to the PM within 4 hours. If serious laboratory issues are discovered, the Navy will be notified.
Data tracking from field collection to database upload Release of analytical data	Project Chemist CH2M	Mark Cichy	(530) 229-3274	Tracks data from sample collection through database upload daily. No analytical data can be released until validation of the data is completed and has been approved by the Project Chemist. The Project Chemist will review analytical results within 7 days of receipt for release to the project team. The Project Chemist will inform the CLEAN Program Chemist who will notify the Navy QAO of any laboratory issues that would prevent the project from meeting project quality objectives or would cause significant delay in project schedule.

SAP Worksheet #6—Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or e-mail	Procedure (timing, pathway to and from, etc.)
Reporting data quality issues	Data Validation PM TBD	TBD	TBD	The data validator reviews and qualifies analytical data as necessary. The data along with a validation narrative are returned to the Project Chemist within 14 calendar days.
Field CAs	CH2M Field Team Leader CH2M PM	Kevin Smallwood Kim Henderson	(970) 250-5441 (619) 272-7209	Field and analytical issues requiring CA will be determined by the Field Team Leader and/or PM on an as-needed basis; the PM will ensure Quality Assurance Project Plan requirements are met by field staff for the duration of the project. The Field Team Leader will notify the PM via phone of any need for CA within 4 hours. The PM may notify the LRPM of any field issues that would negatively affect schedule or the ability to meet project data quality objectives (DQOs).
Changes in the field	Utility Locater Driller Direct-push Technology Provider Surveyor Investigation-derived waste Transportation and Disposal Provider	TBD	TBD	Documentation of deviations from planned field procedures during project work will discussed with PM prior to implementation. Deviations will only be made with approval from the PM.

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SAP Worksheet #7—Personnel Responsibilities and Qualifications

Name	Title/Role	Organizational Affiliation	Responsibilities
Danielle Janda	Navy LRPM	Navy BRAC	Oversees Project.
George (Patrick) Brooks	Navy Project Supervisor	Navy BRAC	Oversees Project.
Zachary Edwards	EPM, Health Physicist	NAVSEA RASO	Provides radiological technical support for the Navy.
Matthew Slack	EPM, Health Physicist	NAVSEA RASO	Provides radiological technical support for the Navy.
Matt Liscio	EPM, Health Physicist	NAVSEA RASO	Provides radiological technical support for the Navy.
Lily Lee	USEPA RPM	USEPA	USEPA POC.
Nina Bacey	RPM	DTSC	DTSC POC.
Janet Naito	Branch Manager, Cleanup	DTSC	DTSC POC.
Sheetal Singh	Environmental Management Branch	CDPH	CDPH POC
Matt Wright	Environmental Management Branch	CDPH	CDPH POC
Tina Low	RPM/Technical Staff Lead	Water Board	Water Board POC.
Amy Brownell	Staff Lead Technical SFDPH	SFDPH	SDPH POC.
Kim Henderson	PM	CH2M	Oversees project activities.
Doug Dronfield	Deputy Program Manager	CH2M	Oversees program.
Scott Hay	Radiological Lead	Cabrera	Provides subject matter support for project approach and execution.
John Hackett	Radiological Lead	CH2M	Provides subject matter support for project approach and execution.
Loren Kaehn	Health and Safety Manager	CH2M	Provides subject matter support for project approach and execution.
Anita Dodson	Program Chemist	CH2M	Provides Uniform Federal Policy (UFP)-SAP project delivery support, reviews and approves UFP-SAPs, and performs final data evaluation and QA oversight.
Janna Staszak	UFP-SAP Reviewer	CH2M	Reviews and approves changes or revisions to the UFP-SAP.

SAP Worksheet #7—Personnel Responsibilities and Qualifications (continued)

Name	Title/Role	Organizational Affiliation	Responsibilities
Mark Cichy	Project Chemist	CH2M	Data management: Performs data evaluation and QA oversight, is the POC with laboratory and validator for analytical issues.
Kevin Smallwood	Field Team Leader	CH2M	Coordinates all field activities and sampling.
TBD	Field Staff	CH2M, Perma-Fix	Conducts field activities.
Valerie Davis	Analytical Laboratory PM	GEL	Manages samples tracking and maintains good communication with Project Chemist.
Bob Pullano	Laboratory QAO	GEL	Responsible for audits, CA, and checks of QA performance within the laboratory.
TBD	Analytical Data Validation PM	TBD	Validate laboratory data from an analytical standpoint prior to data use.

SAP Worksheet #8—Special Personnel Training Requirements

Project Function	Specialized Training by Title or Description of Course	Training Provider	Training Date	Personnel/ Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records/Certificates
Radiological	General Employee Radiological Training	See Appendix D of the Parcel G Work Plan	Prior to initiation of fieldwork	All workers	All workers	Project File
	Radiological Worker Training and Certification	See Appendix D of the Parcel G Work Plan	Prior to initiation of fieldwork	All workers performing radiological work	Radiation Control Technician	Project File
	Radiological Control Technician Training and Certification	U.S. Department of Energy core, North East Utility Exam, National registry of Radiation Protection Technologists, etc. (Appendix D of Parcel G Work Plan)	Prior to initiation of fieldwork	All workers performing radiological work	Radiation Control Technician	Project File

Notes:

In addition to health and safety-related training, other training may be required as necessary as outlined in the APP/SSHP.

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SAP Worksheet #9—Project Scoping Session Participants Sheet

Project Name:	Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan) Radiological Data Evaluation and Confirmation Survey, Former Hunters Point Naval Shipyard			**Site Name:** HPNS	
Projected Date(s) of Sampling: 2018-2019				**Site Location:** San Francisco, California	
Project Manager: Kim Henderson (619) 272-7209					
Date of Session: December 7, 2016					
Scoping Session Purpose:	To introduce team members, discuss radiological data evaluation and community outreach activities, and gain feedback, input, and buy-in from stakeholders.				
Name	**Title**	**Affiliation**	**Phone #**	**E-mail Address**	**Project Role**
Danielle Janda	LRPM	Navy BRAC	(619) 524-6041	danielle.janda@navy.mil	LRPM
Derek Robinson	BEC	Navy BRAC	(619) 524-6026	derek.robinson@navy.mil	BEC
Pat Brooks	BLTL/PM	Navy BRAC	(619) 524-5724	george.brooks@navy.mil	PM and BLTL
Bill Franklin	Public Affairs Officer	Navy BRAC	(619) 524-5433	william.d.franklin@navy.mil	Com Inv Lead
Lily Lee	RPM	USEPA	(415) 947-4187	lee.lily@epa.gov	Staff Lead Technical USEPA
Jackie Lane	Com Inv Coordinator	USEPA	(415) 972-3236	lane.jackie@epa.gov	Staff Lead Com Inv USEPA
David Yogi	Manager, Com Inv	USEPA	(415) 972-3350	yogi.david@epa.gov	Mid Manager Com Inv USEPA
Tamsen Drew	Senior PM/OCII Staff Lead	OCII (San Francisco)	(415) 749-2539	tamsen.drew@sfgov.org	Senior PM/OCII Staff Lead
Amy Brownell	Engineer	SFDPH	(415) 252-3967	amy.brownell@sfdph.org	Staff Lead Technical SFDPH
Scott Hay	Principal Health Physicist	Cabrera Services	(410) 332-8177	shay@cabreraservices.com	Principal Health Physicist
Janet Naito	Branch Manager, Cleanup	DTSC	(510) 540-3833	janet.naito@dtsc.ca.gov	Mid Manager Technical DTSC
Nina Bacey	RPM	DTSC	(510) 540-2480	juanita.bacey@dtsc.ca.gov	Staff Lead Technical DTSC
Sheetal Singh	Mid Manager CDPH	CDPH Environmental Health Branch	(916) 449-5691	sheetal.singh@cdph.ca.gov	Mid Manager CDPH

SAP Worksheet #9—Project Scoping Session Participants Sheet (continued)

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Robert Kirkbright	Program Manager	CH2M	(619) 687-0120 x37276	robert.kirkbright@ch2m.com	Program Manager
Jeff Wong	--	CDPH Radiological Health Branch	--	jeff.wong@cdph.ca.gov	--
Tina Low	RPM	Water Board	(510) 622-5682	tina.low@waterboards.ca.gov	Staff Lead Technical Water Board
Kellie Koenig	Vice President	CH2M	(619) 272-7217	kellie.koenig@ch2m.com	Vice President
Adam Engel	Health Physicist	CH2M	(619) 272-7286	adam.engel@ch2m.com	Data Reviewer
LCDR Soric	--	NAVSEA RASO	--	--	--
Lindsey Land	--	--	--	--	--
Matthew Slack	Environmental PM	NAVSEA RASO	(757) 887-4212	matthew.slack@navy.mil	Technical Expert Navy
Dr. Stephen Doremus	Former Director	NAVSEA RASO	--	--	--
Zachary Edwards	Manager, Health Physicist	NAVSEA RASO	(757) 887-7762	zachary.edwards@navy.mil	Technical Expert Navy
Jana Dawson	Health Physicist (Techlaw Contractor)	USEPA	--	jdawson@techlawinc.com	Technical Expert USEPA
Karla Brasaemle	Geologist (Techlaw Contractor)	USEPA	--	kbrasaemle@techlawinc.com	Technical Expert USEPA
Mark Luckhardt	--	Five Point	--	--	--

Comments/Decisions:

A detailed summary of the meeting is included in **Attachment 1**.

SAP-specific Action Items:

- Determine whether pre-2006 data were used for decision making.
- Provide library of compiled questions and answers on community outreach to share with team.

SAP Worksheet #9—Project Scoping Session Participants Sheet (continued)

Consensus Decisions:

- USEPA, DTSC, and the project team agreed that if the pre-2006 data were superseded by other work done after 2006, the pre-2006 data do not need to be analyzed.
- Statistical tests will identify anomalies in the data, including running tests designed to identify instances where data may have been falsified. It was agreed that areas of highest potential risk should be the priority.

Follow-up:

The Navy assembled a Technical Team (a group of technical experts) that includes representatives from the Navy, USEPA, DTSC, CDPH, and the City of San Francisco. The Technical Team conducted an evaluation of previous HPNS data in light of the claims made and is developing an approach for follow-up investigations. The Technical Team has met twice a month beginning in 2017 to discuss project updates and review documents. As an outcome of the ongoing working meetings, it was concluded that the evaluation may not have identified all instances of potential data manipulation or falsification. Through review of previously submitted iterations of the work plan, it was determined that the investigation approach for collection and evaluation of data will be based on the Parcel G ROD (Navy, 2009) and the Basewide Radiological Management Plan (TtEC, 2012).

To achieve a high level of confidence that ROD RGs have been met for soil (Attachment 2.1 in Appendix A of the Parcel G Work Plan and **Attachment 1** of this SAP), a phased approach was designed based on a proposal by the regulatory agencies. For Phase 1, 100 percent of soil will be re-excavated and characterized at 33 percent of TUs in Parcel G. Soil sampling and scanning at the remaining 67 percent of TUs will be performed as part of Phase 2 to increase confidence that current site conditions comply with the Parcel G ROD remedial action objective (RAO). The Navy will re-excavate 100 percent of Phase 2 TUs if contamination is identified in Phase 1 TUs. At the surface soil SUs from the Buildings 317/364/365 Former Building Site and Building 351A Crawl Space, and for building surfaces, the work plan details an approach that was designed based on regulatory comments on the draft work plans.

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SAP Worksheet #10—Conceptual Site Model

This section provides an updated conceptual site model (CSM) (**Table 10-1**). The CSM summarizes the site description, history, and current status related to radiologically impacted buildings and former building areas, and former sanitary sewers and storm drains identified in the Historical Radiological Assessment (HRA) (NAVSEA, 2004). The sanitary sewers and storm drains were once a combined system identified as radiologically impacted because of the possibility that radioactive waste materials had been disposed of in sinks and drains, and the potential for the surrounding soil to be impacted by leakage and soil mixing during repairs. A removal action was initiated in 2006 to remove the sanitary sewers and storm drains. The removal action included excavation of overburden soil, removal of pipelines, plugging of open sanitary sewers and storm drains left in place during the removal process, ex situ radiological screening and sampling of the pipeline, and performance of final status surveys of the excavated soil and exposed excavation of trench surfaces. Soil was removed to a minimum of 1 foot below and to the sides of the sanitary sewer and storm drain piping.

Following the investigation and removal actions, there were allegations that TtEC potentially manipulated and falsely represented data, and some allegations have since been confirmed. In addition, the onsite laboratory used a screening method to analyze radium-226 (^{226}Ra) that may have reported at levels higher than actual radioactivity. TtEC presented CSMs in remedial action completion reports (RACRs) that were based on potentially falsified data and screening results for ^{226}Ra reported by the onsite laboratory (results were biased high).

As a result, the Navy will conduct investigations at radiologically impacted soil and buildings in Parcel G that were surveyed by TtEC. The results of additional investigation activities presented in this SAP and the Parcel G Work Plan will be used to update the CSM as needed.

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SAP Worksheet #10—Conceptual Site Model (continued)

Table 10-1. Conceptual Site Model

<table>
<tr><th colspan="2">Site Name</th><th>Former Hunters Point Naval Shipyard (Parcel G)</th></tr>
<tr><td colspan="2">Site Location</td><td>Located on San Francisco Bay near the southeastern boundary of San Francisco, California. HPNS encompasses approximately 848 acres, including approximately 416 acres on land, at the point of a high, rocky, 2-mile-long peninsula projecting southeastward into San Francisco Bay. Parcel G occupies 40 acres in the middle of HPNS (Figure 10-1).</td></tr>
<tr><td colspan="2">Site Operations and History</td><td>• NRDL activities associated with analyzing samples from nuclear weapons tests, scientific studies (fallout, plant, animal, materials), and production and use of calibration sources.
• The HRA also documents in Table 5-1 that the Navy had five radioactive licenses with the Atomic Energy Commission for ^{137}Cs, one for a quantity of 3,000 curies and a separate quantity of 20 curies of ^{137}Cs. Two licenses indicate that ^{137}Cs was in sources. In some cases, the Navy made their own sources with ^{137}Cs. Use of radiography sources.
• Use and potential disposal of radiological commodities, including discrete devices removed from ships (deck markers, radium dials) and welding rods.
• Historical radiological material use documented in the HRA (NAVSEA, 2004) lists “impacted sites” – sites with potential for radioactive contamination.
• Former surface soil impacted by fallout may be subsurface soil today because of fill activities.</td></tr>
<tr><td colspan="2">Historical Site Conditions</td><td>Facility created from fill with some background levels of radionuclides (e.g., NORM and fallout). Dredge spoils from local berths were used as fill for some areas. Trenches were backfilled following removal of sewer lines. Trench backfill is mixed, but documentation of source is available (onsite fill, offsite fill, or mixture). Bay mud or bedrock marks bottom extent of fill material.
Site drainage system was designed in the 1940s to discharge to San Francisco Bay and was separated into sanitary sewers and storm drains in 1958, 1973, and 1976, but never completed.</td></tr>
<tr><td>Potential Source Areas</td><td>Potential Historical Sources of Radiological Contamination</td><td>• Potential spills and releases from the following:
– Storage of samples from nuclear weapons tests at various NRDL facilities
– NRDL waste disposal operations:
▪ Liquid waste stored in tank and processed at Building 364
▪ Animal research at Building 364
• Incidental disposal of radioluminescent commodities (e.g., dials, deck markers) during maintenance, individually or attached to equipment.
• Leaking radiography and calibration sources could affect buildings listed in HRA Table 6-1 related to production and maintenance of calibration sources.
• Small amounts of low-level radioactive liquid waste were authorized for release with dilution to sanitary sewers based on regulations in place at the time.</td></tr>
</table>

Table 10-1. Conceptual Site Model

	Release Areas in Parcel G	**Known Release Areas (from Section 6.4 of the HRA):** • Building 351A: – Contaminated sinks and drain lines in Room 47 were removed • Buildings 317/364/365 Site: – "Peanut Spill" (small peanut-shaped spill adjacent to Building 364) – Liquid waste tanks removed – Contamination identified in yard and removed – Contaminated sinks and drain lines connected to the liquid waste tanks, not to the sanitary sewer, were removed **Potential Releases Identified after the HRA:** • Building 366 ventilation and potential releases to soil.

Table 10-1. Conceptual Site Model

	Impacted Buildings in Parcel G	**Impacted Buildings with High Contamination Potential (from Table 8-2 of HRA):** • Building 364 (demolished) - Previously a concrete structure, measuring approximately 40 feet by 50 feet, used as an animal irradiation and research facility, for isotope processing and decontamination studies, and as a general research laboratory. Building 364 also contained a hot cell used to perform some of these processes. A liquid radioactive waste collection area was previously located at the rear of the building. Following closure of HPNS, it was leased to a laboratory company, which performed assay operations and has since been demolished. **Impacted Buildings with Moderate Contamination Potential (from Table 8-2 of HRA):** • Building 351 - Vacant three-story reinforced-concrete shop building with a five-story tower at the northwestern corner, covering approximately 35,166 square feet (ft^2) of floor space. Building 351 was previously used as an electronics work area/shop, optical laboratories, Navy Bureau of Medicine and Surgery storeroom, machine shop (first floor), sampling laboratory, general research laboratories, and biological research laboratories. The NRDL also used the building as materials and accounts division, technical information division, office services branch, thermal branch, engineering division, and library. • Building 351A - Vacant one-story concrete building, covering approximately 35,166 ft^2 of floor space, constructed in 1952 over a crawl space that abuts the southern end of the building. Building 351A was used as a radiation detection, indication and computation repair facility and electronics shop for radiation detection equipment and a facility for the calibration, repair, and reconditioning of other instruments. The NRDL also used the building as a chemistry laboratory, applied research branch, administrative offices, nuclear and physical chemistry laboratory, and chemical technology division. • Building 366 - Vacant, one-story, raised-ceiling structure composed of an exterior "sheet metal" shell with interior room constructed of traditional wood and sheetrock materials, measuring approximately 280 feet by 130 feet. The building was built over a full-floor concrete pad with isolated areas of asphalt patching. Building 366 was used as administrative offices, applied research and technical development branches, radiological safety branch, management planning division, nucleonics division, instruments evaluation section, general laboratories, chemical research laboratory, shipyard radiography shop, boat/plastic shop, and other military/navy branch project officers station. NRDL also used the building for instrument calibration and management engineering and comptroller department. • Building 408 (demolished) – Previously a steel-framed structure enclosing two free-standing furnaces, used for smelting, that were constructed in 1947. The building was the equivalent of three stories at its northern end, dropping to one story at its southern end, and open-sided on the north. A firebrick-lined hearth occupied most of the open area at the north. Natural gas burners were present on the eastern and western sides of the hearth, and a pair of smokestacks extended from the lower rear segment of the building. The building has been demolished, and the concrete building pad is all that remains.

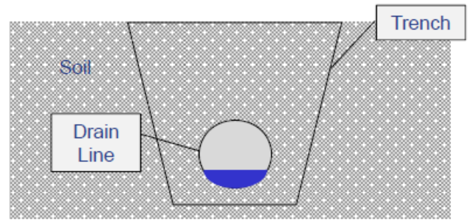
SAP Worksheet #10—Conceptual Site Model (continued)

Table 10-1. Conceptual Site Model

<table>
<tr><td rowspan="1">Potential Source Areas</td><td>Impacted Buildings in Parcel G</td><td>Impacted Buildings with Low or No Contamination Potential (from Table 8-2 of HRA):
• Building 317 (demolished) - Previously a concrete structure measuring approximately 30 feet by 40 feet, used by NRDL personnel for temporary animal quarters.
• Building 365 (demolished) - Previously a wooden structure with a concrete foundation that measured approximately 30 feet by 40 feet. Building 365 was used as a personnel decontamination facility, change house, and storage building. The NRDL also used the building as a small animal facility.
• Building 411 - Vacant curtain-walled, steel-framed building with a flat roof and includes a saw-toothed series of rooftop monitors as well as bands of steel industrial sash and large glazed industrial doors, measuring approximately 185,000 ft^2. Building 411 was used for source storage, as a civilian cafeteria, shipfitters and boilermakers shop, and ship repair shop. A leading enclosure measuring approximately 25 feet by 15 feet was in the building and housed an x-ray machine used for radiography.
Buildings Identified after the HRA:
• Building 401 - Vacant two-story building measuring approximately 100 feet by 250 feet. Building 401 was previously used as a supply storehouse, trades shop, and general stores, and by public works as a maintenance shop and offices. In 2005, the civilian tenant had been made aware of the presence of gauges and dials containing ^{226}Ra and provided the gauges and dials to the Navy.
• Building 439 - Vacant one-story building measuring approximately 250 feet by 400 feet. Building 439 was previously used by the Navy as an equipment storage facility. Following closure of HPNS, the building was leased by a skateboard company for use as a manufacturing and assembly plant. In 2002, Young Laboratories, a civilian tenant, was relocated to a 40-foot by 50-foot enclosed area in the northwestern corner of the building with a separate outside entrance. Young Laboratories processed and analyzed metals and other materials containing metals as part of its assay operations. Previous investigations in Building 364 identified an old kiln that was assumed to have been used by Young Laboratories and a subsequent survey identified slag material inside containing ^{226}Ra. Additional surveys within Building 364 identified areas of elevated ^{137}Cs activity. The Navy identified Building 439 as potentially impacted based on potential cross-contamination from Building 364 during relocation.
The Navy has found radiological contamination in portions of Parcel G, such as in the southeastern corner (associated with the buildings and the peanut spill) and in the sewers along Cochrane Street because of previous testing during the Phase I through Phase V radiological investigations/cleanups. The HRA indicates that ^{137}Cs was found at high concentrations in sediment from a manhole along Cochrane Street. The HRA documents that the Navy used ^{137}Cs, resulting in liquid waste releases in Building 364 in piping, sinks, and the peanut spill behind the building.</td></tr>
<tr><td colspan="2">Radionuclides of Concern for Parcel G (from Table 8-2 of HRA)[5]</td><td>• ^{226}Ra
• ^{137}Cs
• ^{90}Sr
• ^{60}Co (only for interior surfaces of former Buildings 364 and 365 and Building 411)
• ^{232}Th (only building interior surfaces of Buildings 351, 351A, and 408)
• ^{235}U (only for interior surfaces of former Buildings 364 and 365)
• ^{239}Pu (only for interior surfaces of Building 351A and former Buildings 364 and 365)</td></tr>
</table>

<table>
<tr>
<td>Potential Migration Pathways</td>
<td>

Releases to soil and air.
Releases to sanitary sewer lines.
Buildings with known releases
Releases to storm drains.
Incomplete separation from sanitary sewer lines
Runoff from surface spills.
Releases from potentially leaking storm drain and sanitary sewer lines to surrounding soil (now removed).
Release of sediments from breaks or seams during power washing of drain lines.



Conceptual Cross Section of Drain Lines
</td>
</tr>
</table>

5 The site-specific ROCs for the soil and building investigations are listed in **Worksheet #17.**

SAP Worksheet #10—Conceptual Site Model (continued)

Table 10-1. Conceptual Site Model

Potential Exposure Pathways	• Soil: – External radiation from ROCs – Incidental ingestion and inhalation of soil and dust with ROCs for intrusive activities disturbing soil beneath the durable cover (only construction worker receptor) • Building surfaces: – External radiation from ROCs – Inhalation and incidental ingestion of resuspended radionuclides
Current Status	• HPNS is not an active military installation. In 1991, HPNS was selected for closure pursuant to the terms of the Defense BRAC Act of 1990. For more than 20 years, the Navy leased many HPNS buildings to private tenants and Navy-related entities for industrial and artistic uses. Current leases include art studios and a police department facility. Parcels A, D-2, UC-1, and UC-2 have been transferred to the City and County of San Francisco for nondefense use, and the remaining areas of HPNS are also planned to be transferred. • All known sources of radiological material removed by Navy using standards at the time. – Follow-up investigations resulted in removal of small volumes of soil to meet current RGs. • Sanitary sewer and storm drain removal investigation conducted at Parcel G from 2007 to 2011. – More than 4 miles of trench lines and 50,000 cubic yards of soil investigated and disposed of or cleared for use as onsite fill. – Trench excavations that have been backfilled now contain homogenized soil from onsite fill, offsite fill, or a mixture of both.

Uncertainties	• Lower potential for radiological contamination than originally described in historical CSMs based on the following lines of evidence: – Known sources have been removed. – Sanitary sewers and storm drains, and 1 foot of soil surrounding the pipe removed to the extent practicable. The sewer lines were removed to within 10 feet of all buildings. Impacted buildings had remaining lines removed during surveys of the buildings. Non-impacted buildings had surveys performed at ends of pipes, and pipes were capped. – Any residual concentrations may be modified by radiological decay (shorter-lived radionuclides, such as ^{137}Cs and ^{90}Sr) or remobilization (including weathering and migration). – Sediment data from inside pipe not indicative of a large quantity disposal or contamination (maximum ^{226}Ra concentration of 4.2369 pCi/g and maximum ^{137}Cs concentration of 0.87795 pCi/g in Parcel G). – Overestimate of ^{226}Ra concentrations in soil by the onsite laboratory using an imprecise measurement method. – LLRW bins were tested by the Navy’s independent waste broker at an offsite laboratory using 5-point composites, and only 3 out of 1,411 bins had results with ^{226}Ra above the RGs. • Data manipulation or falsification. • Data quality deficiencies. • ^{137}Cs and ^{90}Sr are present at HPNS because of global fallout from nuclear testing or accidents, in addition to being potentially present as a result of Navy activities. Because of backfill activities, ^{137}Cs and ^{90}Sr from fallout and Navy activities are not necessarily only on the surface and may be present in both surface and subsurface soil. • Potential for isolated radiological commodities randomly distributed around the site. • Trenches where scan data exceeded the investigation level and biased soil samples were not collected.

Notes:

^{60}Co = cobalt-60
^{90}Sr = strontium-90
^{137}Cs = cesium-137
^{232}Th = thorium-232
^{235}U = uranium-235
^{239}Pu = plutonium-239
LLRW = low-level radioactive waste
NORM = naturally occurring radioactive material
NRDL = Naval Radiological Defense Laboratory
pCi/g = picocurie(s) per gram
RG = remediation goal
ROC = radionuclide of concern

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SAP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
State the Problem	**Identify the Objective**	**Identify Inputs to the Objective**	**Define the Study Boundaries**	**Develop Decision Rules**	**Specify the Performance Criteria**	**Develop the Plan for Obtaining Data**
Data manipulation and falsification were committed by a contractor during past sanitary sewer and storm drain removal actions and current and previous soil and building investigations in Parcel G. The Technical Team evaluated soil and building survey data and found evidence of potential manipulation and falsification. The findings call into question the reliability of soil and building data, and there is uncertainty whether radiologica	The primary objectives of the study are as follows: • To determine whether site conditions in soil and building surfaces are compliant with the Parcel G ROD RAO (Navy	The inputs for each component of the study are as follows: • Soil Investigation: – Surface soil and subsurface soil analytical data for the applicable ROCs provided by an accredited offsite laboratory. The ROCs for the soil investigation are listed below and are presented in **Worksheet #17**.	The study boundaries for each component of the study are as follows: • Soil Investigation: – Phase 1 and Phase 2 trench units (TUs) and Former Building Site and Crawl Sp	• If the building and soil investigation results demonstrate that there are no exceedances determined from a point-by-point comparison with the statistically-based[6] RGs at agreed upon statistical confidence levels, or that residual ROC concentrations are NORM or anthropogenic background, then a RACR will be developed. • If the building and soil investigation results demonstrate exceedances of the RGs determin	The performance criteria for each component of the study are as follows: • The soil investigation data evaluation process for demonstrating compliance with the Parcel G ROD RAO is summarized below and depicted on **Figure 11-12**: – Compare each ROC concentration (**Worksheet #17**) for every sample to the corresponding RG (**Worksheet #17**). ▪ If all concentrations for all ROCs for all samples are less than or equal to the RGs, then compliance with the Parcel G ROD RAO is achieved. – Compare sample data to appropriate RBA data from HPNS as described in the Parcel G Work Plan. Multiple lines of evidence will be evaluated to determine whether site	Data for each component of the study will be obtained through the following methods: • Soil Investigation: – For the TUs associated with former sanitary sewers and storm drains (from 1 to 22 feet deep), a phased investigation approach was designed based on a proposal by the regulatory agencies to achieve a high level of confidence that the Parcel G ROD RAO has been met for soil. For Phase 1, 100 percent of soil will be re-excavated and characterized at 33 percent of TUs in Parcel G. Soil sampling and scanning at the remaining 67 percent of TUs was proposed as part of Phase 2 to increase confidence that current site conditions comply with the Parcel G ROD RAO. Evaluation of the results of Phase 1 may lead to re-excavation of Phase 2 TUs. For both Phase 1 TUs and Phase 2 TUs, the durable cover (including asphalt, asphalt base course, concrete, gravel, debris, or obstacles) will be removed to expose the target soils. ▪ Phase 1 TUs – The radiological investigation will be conducted on a

6 The RGs are statistically based because they are increments above a statistical background.

l contamination was present or remains in place. Therefore, the property is unable to be transferred as planned. Based on the uncertainty and the description of radiological activities in the HRA, there is a potential for residual radioactivity to be present in soil and on building interior surfaces. Furthermore, HPNS was expanded over time using fill materials with a range of concentrations of NORM. Construction and remediation projects over the past 60 years have disturbed the surface soil, making a determination of background	, 2009). • To establish representative background soil data sets for comparison and evaluation of soil data collected from HPNS.	▪ ROCs for the Former Sanitary Sewer and Storm Drain Lines are ^{137}Cs, ^{226}Ra, and ^{90}Sr. ▪ ROCs for the Former Buildings 317/364/365 Site are ^{137}Cs, ^{226}Ra, ^{90}Sr, ^{239}Pu, and	ace soil survey units (SUs) listed in **Worksheet #17** and shown on **Figure 11-1**. • Soil RBA Investigation: – RBAs at HPNS in Parcels B, C, D-1, D-2	ed from a point-by-point comparison with the statistically-based[6] RGs at agreed upon statistical confidence levels and are not shown to be NORM or anthropogenic background, then remediation will be conducted, followed by a RACR. – If one Phase 1 TU does not meet the Parcel G ROD RAO, all Phase 2 TUs will be excavated. – If all Phase 1 TUs meet the Parcel G ROD RAO, Phase 2 will be initiat	conditions are consistent with NORM or anthropogenic background. The data evaluation may include, but is not limited to, population-to-population comparisons, use of a maximum likelihood estimate (MLE) or background threshold value (BTV), graphical comparisons, and comparison with regional background levels. ▪ If all residual ROC concentrations are consistent with NORM or anthropogenic background, site conditions comply with the Parcel G ROD RAO. ▪ If any ^{226}Ra gamma spectroscopy concentration exceeds the ^{226}Ra RG and the range of expected NORM concentrations, then the soil sample will be analyzed using alpha spectroscop	targeted group of 21 of the 63 TUs (from 1 to 22 feet deep) associated with former sanitary sewers and storm drains (**Figure 11-1**). The Phase 1 TUs will be investigated using gamma scan surveys and soil sampling as described in **Worksheets #14** and **#17**. ▪ Phase 2 TUs – Gamma scan surveys, soil sampling, and scanning of soil cores will be conducted on the remaining 42 TUs (from 1 to 22 feet deep) in Parcel G (see **Figure 11-1**). The Phase 2 TUs will be investigated as described in **Worksheets #14** and **#17**. Phase 2 will only be performed if no contamination is found during Phase 1. If contamination is found during Phase 1, then all of the Phase 2 TUs will be excavated and investigated following the process described for the Phase 1 TUs. – Former Building Site and Crawl Space Soil SUs - The radiological investigation will be conducted at the 28 SUs[7] associated with surface soil at building sites in Parcel G (**Figure 11-1**). The SUs will be investigated using gamma scan surveys and soil

[7] Previously, 32 SUs were investigated at Buildings 317/364/365 Former Building Site and Building 351A Crawl Space; however, some SU areas overlapped. For the Buildings 317/364/365 Former Building Site, former SU 22 overlaps TU 153 and will be investigated as part of TU 153. For the Building 351A Crawl Space, former SU R, SU S, and SU U overlap SU M, SU N, and SU O and will be investigated as SU M, SU N, and SU O.

concentrations for anthropogenic radionuclides from fallout difficult. Previous HPNS soil background values did not provide ^{226}Ra concentrations representative of all fill materials found at HPNS and did not include other NORM or fallout radionuclides.		^{235}U. ▪ ROCs for the Building 351A Crawl Space are ^{137}Cs, ^{226}Ra, ^{90}Sr, ^{239}Pu, and ^{232}Th. – Gamma scan survey measurements to identify biased soil sample locations. • Soil Reference Background Area (RBA) Investigation: – Soil analytical data for ROCs provided by an accredited offsite laboratory.	(**Figure 11-2**), and an undisturbed off-base location (**Figure 11-3**) will provide a range of background estimates. • Building Investigation: – Accessible interior or	ed for TUs. – If any Former Building Site and Crawl Space Soil SU or Phase 2 TU does not meet the Parcel G ROD RAO, the SU or TU will be excavated. • The RACR will describe the results of the investigation, explain remediation performed, compare the distribution of data from the sites with applicable reference area data, and provide a demonstration that site conditions are compliant with the Parcel G ROD RAO through the use of multiple	y for uranium isotopes (^{238}U, ^{235}U, ^{234}U), thorium isotopes (^{232}Th, ^{230}Th, and ^{228}Th), and ^{226}Ra to evaluate equilibrium conditions. If the concentrations of the radionuclides in the uranium natural decay series are consistent with the assumption of secular equilibrium, then the ^{226}Ra concentration is NORM and site conditions comply with the Parcel G ROD RAO. – If any result is greater than the RG and cannot be attributed to NORM or anthropogenic background, remediation will be performed prior to backfill.	sampling as described in **Worksheets #14** and **#17**. ▪ At the Former Buildings 317/364/365 Site, SUs 27 (peanut spill) and 28 (liquid waste transfer system [LWTS]) will be excavated to 2 and 10 feet below ground surface (bgs), respectively, for consistency with the previous excavation boundaries. The two SUs will be excavated to the original excavation boundaries, as practicable, and gamma scans of the excavated material will be conducted following the process described for Phase 1 TUs (**Worksheets #14** and **#17**) – The soil samples collected will be analyzed as described below for the applicable ROCs by accredited offsite laboratories and the results will be evaluated as described in Step 6. The excavated soil from within each trench and over-excavation will be tracked separately, and global positioning

		All RBA samples will be analyzed by the respective method for the radionuclides listed in **Worksheets #15a**, **#15b**, **#15c**, and **#15d**. – Gamma scans of accessible surface areas performed within the RBAs to confirm the areas are free of elevated gamma levels and are suitable for sampling.	surfaces of Buildings 351, 351A, 366, 401, 411, and 439, the concrete pad at former Building 408, and Building 404, which will be used as the prim			

			ary RBA (**Figure 11-4**). The building floor plans (i.e., Class 1 and 2SUs) are depicted on			

SAP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements (continued)

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
State the Problem	**Identify the Objective**	**Identify Inputs to the Objective**	**Define the Study Boundaries**	**Develop Decision Rules**	**Specify the Performance Criteria**	**Develop the Plan for Obtaining Data**

		• Building Investigation: – Alpha-beta static, alpha and beta scan, and alpha-beta swipe data collected by radiological survey instruments on buildings and reference area surfaces. Radioactivity concentration data for material or swipe samples provided by an accredited offsite laboratory (if needed).	**Figures 11-5 through 11-11.**	lines of evidence including application of statistical testing with agreed upon statistical confidence levels on the background data. RBA data sets will be compared and evaluated to provide representative RBA data sets with a description to assist in determining applicability for specific projects at HPNS. The data evaluation process is summarized below and detailed in Appendix C of the Parcel G Work Plan: – Identify outliers graphically or statistically using Dixon and Rosner’s tests for outliers (or other appropriate tests, including non-parametric methods) by comparing the calculated Q values or R values to the critical value, corresponding to a confidence level of 95 percent. ▪ If outliers are identified graphically or statistically (Q value or R value is greater	• The soil RBA investigation statistical data evaluation will be conducted to identify appropriate soil background data sets and calculate descriptive statistics to facilitate future comparisons with site-specific data. The purposes of the data evaluation are summarized below. Additional detail is provided in the Parcel G Work Plan. – Identify outliers using Dixon and Rosner’s tests for outliers (or other appropriate tests, including non-parametric methods). – Determine statistical differences between soil types using the KW test. – Compare soil data sets from surface gamma scan surveys, and surface and subsurface analytical concentrations against different identified soil types and against each RBA per sample depth.	system (GPS) location-correlated results will be collected or surveying conducted. ▪ All soil samples at a minimum will be assayed by gamma spectroscopy for ^{137}Cs and ^{226}Ra. Gamma spectroscopy data will be reported by the laboratory after a full 21-day in-growth period. If the laboratory results indicate a concentration of ^{226}Ra above the RG (**Worksheet #15a**), the sample will be analyzed using alpha spectroscopy for uranium isotopes (^{238}U, ^{235}U, ^{234}U), thorium isotopes (^{232}Th, ^{230}Th, and ^{228}Th), and ^{226}Ra. If the laboratory results indicate concentrations of

				than critical value), the outlier will be investigated to attempt to determine whether the outlier is the result of contamination, data quality issues, an environmental issue (e.g., different soil type), or an unidentified issue. ▪ If no outliers are identified, the entire data set will be used in its entirety. – Determine statistical difference between data sets using the non-parametric Kruskal-Wallis (KW) test by comparing the calculated p-value against 0.05 significance level.	– Establish one or more representative reference area data sets. • The building investigation data evaluation process for demonstrating compliance with the Parcel G ROD is presented as follows and depicted on **Figure 11-13**: – Compare each net alpha and net beta result to the corresponding RG from **Worksheet #17**: ▪ If all results are less than or equal to the RGs, then compliance with the ROD RAO is achieved. – Compare survey data to appropriate RBA data from HPNS as described in the Parcel G Work Plan. Multiple lines of evidence will be evaluated to determine whether site conditions are consistent with NORM or anthropogenic background. The data evaluation	^{137}Cs above its RG (**Worksheet #15a**), the sample will be analyzed for ^{90}Sr and by alpha spectroscopy for ^{239}Pu. ▪ Additionally, at least 10 percent of randomly selected samples will receive gas flow proportional analysis for ^{90}Sr. If the laboratory results indicate the presence of concentrations of ^{90}Sr at or above the respective RG (**Worksheet #15c**), the sample will be analyzed by alpha spectroscopy for ^{239}Pu (**Worksheet #15b**). Furthermore, a minimum of 10 percent of systematic soil samples collected from the

					may include population-to-population comparisons, use of an MLE or BTV, and graphical comparisons. ▪ If survey data are consistent with NORM or anthropogenic background, then site conditions comply with the Parcel G ROD RAO. ▪ If any result is greater than the RG and cannot be attributed to NORM or anthropogenic background, remediation will be conducted.	Former Buildings 317/364/365 Site will be randomly selected for alpha spectroscopy analysis for ^{239}Pu. • Soil RBA Investigation: – The soil RBAs will be investigated using gamma scan surveys of the accessible surface soil and collection of systematic surface and subsurface soil samples as described in **Worksheets #14** and **#17**. ▪ Soil samples will be analyzed for the applicable ROCs along with NORM radionuclides and fallout radionuclides by accredited offsite laboratories (**Worksheets #15a**, **#15b**, **#15c**, **#15d**). • Building Investigation: Building investigations will be conducted on floors, wall surfaces, and

						ceiling surfaces, and will consist of alpha and beta scan surveys, alpha-beta static measurements, and alpha-beta swipe samples as described in **Worksheets #14** and **#17**.

SAP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements (continued)

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
State the Problem	**Identify the Objective**	**Identify Inputs to the Objective**	**Define the Study Boundaries**	**Develop Decision Rules**	**Specify the Performance Criteria**	**Develop the Plan for Obtaining Data**
				If the results of the KW test indicate that two or more data sets are statistically similar (p-value is greater than significance level), those data sets may be combined to form a larger data set representing more of HPNS, such as a larger area, multiple soil depths, or additional soil types. ▪ If the results of the KW test indicate that a data set is statistically different from other data sets (p-value is less than significance level), that data set will not be combined with other data sets and will be representative of a specific area, soil depth, or soil type. ▪ Evaluate secular equilibrium conditions.		

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SAP Worksheet #12—Field Quality Control Samples – Soil Measurement Performance Criteria Table – Field QC Samples

QC Sample	Analytical Group	Frequency	Data Quality Indicators	Measurement Performance Criteria
Field Duplicate	Radiological (alpha and gamma spectroscopy, Gas Flow Proportional Counting [GFPC], radon emanation)	One per every 10 field samples collected.	Precision	Relative percent difference (RPD) < 25 percent
Equipment Blank		One per day of field sampling for decontaminated equipment.	Bias/Contamination	No target analytes detected > minimum detectable concentration (MDC)
Field Blank		One per source water per sampling event.	Bias/Contamination	No target analytes detected > MDC
Split Sample[a]		All soil samples will be retained for possible CDPH confirmatory analysis until the final RACR for Parcel G is issued.	N/A	None

Notes:

[a] May be collected if requested by other stakeholders (USEPA or CDPH) and will be evaluated by the stakeholder. Measurement and performance criteria will be outlined in the stakeholder guidance documents.

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SAP Worksheet #13—Secondary Data Criteria and Limitations

Secondary Data	Data Source (originating organization, report title, and date)	Data Generators (originating organization, data types, data generation/collection dates)	How Data Will be Used	Limitation on Data Use
Remediation Goals	Department of the Navy *Basewide Radiological Removal Action, Action Memorandum–Revision 2006* April 2006 (Navy, 2006)	Navy, RGs for soil and surfaces	To determine whether site conditions in soil and building surfaces are compliant with the Parcel G ROD RAO (Navy, 2009), analytical and building data will be compared to the RGs for Parcel G ROCs.	The RGs will be applied as concentrations above background.
Trench Unit, Survey Unit Boundaries and Depths	TtEC *Multiple plans and reports and the Parcel G Remedial Action Completion Report* 2010 - 2011	TtEC, site figures, building layouts, floor plans	Data will be used as the boundaries for TUs and SUs included in the Soil and Building Investigations.	Electronic versions of previous excavations and are not available. Alterations of building interiors may have taken place. Therefore, best management practices (BMPs) will be used to locate and mark the boundaries of former TUs and SUs.

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SAP Worksheet #14—Summary of Project Tasks

This worksheet contains procedures for field activities as a supplement to the Parcel G Removal Site Evaluation Work Plan, which contains detailed information on the radiological support activities that will be conducted during the soil and building investigation activities outlined in this SAP. Field standard operating procedures (SOPs) specific to the soil sampling and building investigation discussed in this SAP are presented in **Worksheet #21**. All radiological support work will be performed in accordance with the radiological SOPs, which are included as Appendix D of the Parcel G Work Plan.

Premobilization Activities

Before initiating field investigations, several premobilization steps will be completed to ensure that the work can be conducted in a safe and efficient manner. The primary premobilization tasks include procurement of subcontractor services, training of field personnel, permitting and notification, a pre-construction meeting, offsite RBA access, and building walkthroughs, as described below.

Procurement of Subcontractor Services

A list of the various support services that are anticipated to be required are as follows:

- Radiological analytical laboratory services
- Drilling subcontractor
- Civil surveying subcontractor
- Utility location subcontractor
- Vegetation clearance subcontractor
- Transport (trucking) subcontractor
- Concrete coring subcontractor

Permitting and Notification

Before initiation of field activities for the radiological investigation, the contractor will notify the Navy RPM, Resident Officer in Charge of Construction (ROICC), RASO, and HPNS security as to the nature of the anticipated work. Any required permits to conduct the fieldwork will be obtained before mobilization.

The contractor will notify the CDPH at least 14 days before initiation of activities involving the Radioactive Material License.

Pre-Construction Meeting

A pre-construction meeting will be held before mobilization of equipment and personnel. The purpose of the meeting will be to discuss project-specific topics, roles, and responsibilities of project personnel, project schedule, health and safety concerns, and other topics that require discussions before field mobilization. Representatives of the following will attend the pre-construction meeting:

- Navy (RPM, RASO, ROICC, and others as applicable)
- Contractor (PM, Site Construction Manager, Project QC Manager, RSO, and SSHO)
- Subcontractors as appropriate

Offsite Reference Background Area Access

Prior to initiation of the RBA investigation, coordination with the City of San Francisco will be conducted to facilitate access and approval for sampling and ground disturbance activities at McLaren Park. Sampling at McLaren Park will be conducted only if access and approval are granted.

SAP Worksheet #14—Summary of Project Tasks (continued)

Building Walkthroughs

Prior to the start of building survey activities, a walk-through of Parcel G buildings will be completed to accomplish the following:

- Establish building access points and assess security requirements.
- Assess survey support needs such as power, lighting, ladders, or scaffolding.
- Verify the types of materials in each SU.
- Identify safety concerns and inaccessible or difficult-to-survey areas.
- Identify radiological protection and control requirements.
- Identify materials requiring removal or disposal, and areas requiring cleaning.
- Assess methods for marking survey scan lanes and static measurement locations.

Impacted areas that are deemed unsafe for access or surveying, such as the mezzanine of Building 411 (SU 1), will be posted, secured, and noted in reports.

Mobilization Activities

At least 2 weeks before mobilization, the appropriate Navy personnel, including the Navy RPM and ROICC and Caretaker Site Office, will be notified regarding the planned schedule for mobilization and site investigation activities. Upon receipt of the appropriate records and authorizations, field personnel, temporary facilities, and required construction materials will be mobilized to the site.

The applicable activity hazard analysis forms will be reviewed prior to starting work. The temporary facilities will include restrooms, hand-washing stations, and one or more secure storage (Conex) boxes for short- and long-term storage of materials, if needed.

The mobilization activities are summarized below and are described in detail in the Parcel G Work Plan.

Soil Investigation

The mobilization activities for the soil investigation will include the following:

- Locating and confirming soil TU and SU boundaries.
- Establishing a radiologically controlled area.
- Implementation of stormwater, sediment, and erosion control measures.
- Implementation of dust control methods and air monitoring.
- Underground Service Alert will be contacted at least 72 hours before initiating intrusive activities.
- Removal and survey of the durable cover of Phase 1 TUs and Phase 2 TUs.
- Movement of equipment and materials to the site. All equipment mobilized to the site will undergo baseline radioactivity surveys in accordance with the Parcel G Work Plan. Surveys will include directs scans, static measurements, and swipe samples. Equipment that fails baseline surveying will be removed from the site.

Reference Background Area Investigation

The mobilization activities for the RBAs will include the following:

- Vegetation clearance
- Utility location and clearance
- Surface debris removal
- Locating and marking the planned sample locations (Sample locations are detailed in **Worksheet #17**.)

SAP Worksheet #14—Summary of Project Tasks (continued)

Building Investigation

The mobilization activities for the building investigation will include the following:

- Removal of loose, residual debris to prepare the buildings for cleaning.
- Implementation of dust control methods and air monitoring, if warranted.
- Cleaning of floors, walls, and other surfaces.
- Evaluation and disposal of waste generated from cleaning activities.
- Movement of equipment and materials to the site. All equipment mobilized to radiologically controlled areas will undergo baseline radioactivity surveys in accordance with the Parcel G Work Plan. Surveys will include directs scans, static measurements, and swipe samples. Equipment that fails baseline surveying will be removed from the site.

Investigation Activities

Once site preparation activities are completed, investigation activities will commence. The following sections describe the field activities specific to each component of the investigation. The survey design for each component is described in detail in the Parcel G Work Plan and summarized in **Worksheet #17**.

Soil Investigation

There are two types of Parcel G soil investigations, including surveys of the following:

- Surface and subsurface soil associated with former sanitary sewer and storm drain lines (TUs)
- Surface soil areas associated with soil from building sites (SUs)

A two-phased approach is planned for the investigation of surface and subsurface TU soil associated with former sanitary and storm drain lines. For surface soil areas associated with soil from building sites, radiological investigation will be conducted at 28 SUs[8] in Parcel G.

The size and boundary of the TUs and SUs will be based on the previous plans and reports. Locating and marking the boundaries of the former TUs and SUs will be accomplished by using BMPs to identify boundaries and depths of the former TUs and SUs based on the previous TtEC reports (e.g., survey reports, drawings, and sketches), field observations (such as GPS locations from geo-referencing, borings, and visual inspection), and durable cover as-built records (**Worksheet #13**). Once the boundaries are located, the areas will be marked with paint or pin flags.

Phase 1 Trench Unit

Each Phase 1 TU (**Worksheet #17**) will be excavated to the original excavation limits and evaluated in approximately 152-cubic-meter (~200-cubic-yard) excavated soil units (ESUs). Once the excavation to the original excavation limits has been complete, over-excavation of at least an additional 6 inches outside the estimated previous boundaries of the sidewalls and bottom will be initiated. This exhumed over-excavated material will be maintained separately from the ESUs and will represent the trench sidewalls and floor (sidewall floor unit or SFU).

[8] Previously, 32 SUs were investigated at Buildings 317/364/365 Former Building Site and Building 351A Crawl Space; however, some SU areas overlapped. For the Buildings 317/364/365 Former Building Site, former SU 22 overlaps TU 153 and will be investigated as part of TU 153. For the Building 351A Crawl Space, former SU R, SU S, and SU U overlap SU M, SU N, and SU O and will be investigated as part of SU M, SU N, and SU O.

SAP Worksheet #14—Summary of Project Tasks (continued)

The excavated material (ESUs and SFUs) will undergo radiological assay following either the automated soil sorting process (if approved by CDPH and USEPA) or Radiological Screening Yard (RSY) pad process. Excavated TU materials will be transported to the soil sorting area or RSY pad by dump truck or other conventional means. Excavated soil entering an RSY must be accompanied by a truck ticket (paper or digital), to facilitate transfer of the material for radiological processing along a designated truck route. This ticket will provide the RSY staff with the following information:

- Location of excavation, including former TU name
- From which TU sidewall or floor surface material was excavated (if applicable)
- Load number
- Estimated volume of soil
- Date and time of excavation

The RSY personnel will direct the driver to the appropriate RSY pad for soil placement. The truck ticket will be amended with the assigned unique RSY pad number for tracking purposes. Placement of soil on an RSY pad will continue until the soil placed on the RSY pad reaches capacity as identified by the RSY manager (or designee) and is ready for processing.

One hundred percent of the Phase 1 ESU and SFU soils will undergo scan surveys using real-time gamma spectroscopy equipment in the soil sorting process or the RSY pad process. Following completion of investigation activities, the ESU and SFU material will either be returned to the same trench that the material originated from or will be segregated for further investigation.

The soil sorting system process and RSY pad process are summarized in the following sections. These processes, including associated scanning instrumentation, are described in further detail in the Parcel G Work Plan. A summary of the sampling design and rationale associated with these processes is included in **Worksheet #17**.

Automated Soil Sorting System

Because soil sorting systems are designed to be deployed on a flexible and scalable platform, the system will be tailored to achieve the project-specific requirements and objectives. The configuration details, including detectors, MDCs, and specific operating set points will be provided under separate cover, in a Soil Sorting Operations Plan. The Soil Sorting Operations Plan will be submitted to the regulatory agencies for review and concurrence.

Generally, soil sorting systems are radiological monitoring and processing systems designed to perform real-time segregation of soil into two distinct bins based upon the soil's radiological properties. The material is sorted into two distinct bins (piles), commonly referred to as the "Below Criteria" and "Diverted Pile" bins. The basis upon which the soil material is sorted and segregated into distinct volumes is controlled by the establishment of diversion control setpoints that automatically trigger the diverting mechanism, sorting the material into the appropriate bin. The diversion control setpoints will be chosen as described in the Parcel G Work Plan. Using typical earth moving equipment, such as a front-end loader or excavator, soil from the ESU or SFU will be fed to the soil sorting system. The material will move past the active area of the detectors, and the system's software will interpret the spectroscopy data to determine whether the volume of soil exceeds the specified alarm point. As the material continues to travel up the conveyor, it is automatically sorted in one of two bins.

SAP Worksheet #14—Summary of Project Tasks (continued)

A minimum of 18 systematic soil samples will be collected from each ESU and SFU during assay with the soil sorting system. Additionally, a minimum of one biased soil sample will be collected from the soil material that has been discharged to the Diverted Pile bin. If the soil material discharged to the Diverted Pile originates from an SFU and is confirmed to contain contamination, an in situ investigation of the open trench will be performed at the excavation location of the soil. Material discharged to the Diverted Pile will remain segregated until completion of the investigation activities. The trench under investigation will remain open until investigation and remediation activities are completed. If necessary, additional samples may be collected from diverted material to support characterization for waste disposal.

Soil processed by the soil sorter system and subsequently staged for offsite disposition or onsite reuse will be staged pending evaluation of offsite analytical results and Navy approval for disposition or reuse.

Soil pending offsite analytical results may be staged in stockpiles smaller than 152 m^3, which would permit the re-evaluation of smaller soil volumes should elevated soil sample results be received from the offsite laboratory.

If elevated sample results are identified by offsite analysis, the contractor notify the Navy and determine a suitable soil rescreening process, either by RSY pad or by the soil sorter. SFU sampling locations with concentrations that exceed RGs and background will be remediated by additional soil excavation.

Radiological Screening Yard Pad

If a conveyor-based automatic soil sorting system process is not used, excavated TU material will be assayed using the RSY pad process. RSY pad processing has previously been used at HPNS as described in the Basewide Radiological Management Plan (TtEC, 2012). If no existing RSY pads are available for use, pads will be constructed to meet the requirements specified in the Basewide Radiological Management Plan (TtEC, 2012), RSY Construction Details (TtEC, 2009b), or other current Navy guidance. RSY pads will be constructed with a size limit of 1,000 square meters (m^2). Before construction, the area where the RSY pads will be constructed will be radiological scan-surveyed to document the existing conditions.

Excavated TU materials will be transported to the RSY pad by dump truck or other conventional means and spread approximately 6 to 9 inches thick. Processing activities in the RSY pads include gamma scan surveys, systematic and biased soil sampling and analyses, follow-up investigation activities (as necessary), radiologically clearing the materials for reuse or disposal, and transport of the materials off the RSY pads.

If gamma scan surveys indicate areas of potentially elevated activities as identified in the Parcel G Work Plan, additional investigation will be initiated. At a minimum, the contractor will further evaluate the gamma scan data and collect biased soil samples. Material with potentially elevated concentrations will remain segregated until completion of the investigation activities. If SFU soil sampling indicates areas of potentially elevated activity above the RGs, and it is confirmed that the soil contains contamination, an in situ investigation of the open trench will be performed at the excavation location of the soil. The in situ investigation will include the performance of a gamma scan over the trench surface requiring investigation and additional biased and systematic sampling as described in the Parcel G Work Plan.

Soil processed by the RSY process and subsequently staged for offsite disposition or onsite reuse will be staged pending evaluation of offsite analytical results and Navy approval for disposition or reuse. If elevated sample results are identified by offsite analysis, the contractor shall notify the Navy and determine a suitable soil rescreening process, either by RSY pad or by the soil sorter. SFU sampling locations with concentrations that exceed RGs and background will be remediated by additional soil excavation.

SAP Worksheet #14—Summary of Project Tasks (continued)

Following completion of scan surveys, sampling, and any potential investigation activities, the excavated material will be returned to the same trench that the material originated from. The Navy will re-excavate 100 percent of Phase 2 TUs if contamination is identified in Phase 1 TUs.

Phase 2 Trench Unit

Each Phase 2 TU (**Worksheet #17**) will be investigated using a combination of gamma surface scan, soil core scan surveys, and subsurface soil sample collection. Subsurface soil samples will be collected as described in **Worksheet #21** and **Attachment 2**).

The systematic boring locations will be cored down to approximately 6 inches below the depth of previous excavation within each TU boundary. Sanitary sewer and storm drain lines were sometimes installed on bedrock. In these situations, sampling of bedrock will not be performed. If refusal is encountered within 6 inches of the expected depth of the trench, the soil sample will be collected from the deepest section of the core. If refusal is encountered more than 6 inches above the expected depth of the trench, the sample location will be moved to avoid the subsurface obstruction.

To acquire three samples from each boring, one surface and one floor sample will be collected from each sample core. The sample cores will be scanned for gamma radiation along the entire length of each core, and the scan data will be evaluated to determine whether collection of a biased sample is required as described in the Parcel G Work Plan. If evaluation of scan data does not identify the need for collection of a biased sample, a biased sample will be collected from the core segment with the highest gamma scan reading that was not already sampled, for a total of at least three samples from each core.

Additionally, systematic samples will be collected from sidewall locations every 50 linear feet, representative of each of the trench sidewalls. The boring locations will be located within 1 meter of the previous sidewall excavation limits and will extend to the maximum previous excavation depth. In the same action described in the previous paragraph, core sections will then be retrieved, scanned, and sampled such that at least three samples will be collected from each of the six boring locations.

If GPS reception is available, soil sample locations will be position-correlated with GPS data and recorded. If GPS reception is not available, a reference coordinate system will be established to document gamma scan measurement results and soil sample locations. The reference coordinate system will consist of a grid of intersecting lines referenced to a fixed site location or benchmark. If practical, the GPS coordinates of the fixed location or benchmark will be recorded.

Remediation of soil with analytical results above the RGs and background will be performed by excavation of the identified location of the elevated activity or the by excavation of the complete TU for further processing using the RSY pad or soil sorting processes. Following excavation, a minimum of five bounding confirmation samples will be collected at the lateral and vertical extents to confirm the removal of contaminated soil. If a Phase 2 TU is excavated in its entirety, it will be investigated following the process described for a Phase 1 TU. Material with potentially elevated concentrations will remain segregated until completion of the investigation activities.

Scanning instrumentation used during the investigation of the Phase 2 TUs are described in further detail in the Parcel G Work Plan. A summary of the sampling design and rationale is included in **Worksheet #17**.

Former Building Site and Crawl Space Soil Survey Unit

Surface soil SUs will be characterized in a similar fashion as the RSY process, using a combination of gamma scan surveys and systematic and biased surface soil sampling. Surface soil samples will be collected in accordance with the *Soil Sampling* SOP (**Worksheet #21** and **Attachment 2**).

SAP Worksheet #14—Summary of Project Tasks (continued)

Gamma scan surveys will be performed as described in the Parcel G Work Plan. If GPS reception is available, gamma scan surveys will be position-correlated with GPS data. If GPS reception is not available, which is likely for SUs located within the Building 351A Crawl Space, a reference coordinate system will be established to document gamma scan measurement locations. The reference coordinate system will consist of a grid of intersecting lines referenced to a fixed site location or benchmark. If practical, the GPS coordinates of the fixed location or benchmark will be recorded.

Gamma scanning data sets will be transferred from the data logger onto a computer to create spreadsheets, and if feasible, gamma scan survey results will be mapped. Data obtained during the surface gamma scan surveys will be evaluated to identify areas of potentially elevated activity and locations of biased samples as described in the Parcel G Work Plan.

Following the completion of the gamma scan surveys, a minimum of 18 systematic samples will be collected from each soil SU. A summary of the sampling design and rationale is included in **Worksheet #17**.

At the Former Buildings 317/364/365 Site, SUs 27 (peanut spill) and 28 (LWTS) will be excavated to 2 and 10 feet bgs, respectively, <u>for consistency with the previous excavation boundaries</u> (**Figure 11-1**). The two SUs will be excavated to the original excavation boundaries, as practicable, and gamma scans of the excavated material will be conducted following the process described for Phase 1 TUs.

Reference Background Area Investigation

Each RBA (**Worksheet #17**) will be investigated using a combination of gamma scan measurements, and surface and subsurface soil sampling. Surface and subsurface soil samples will be collected in accordance with the *Soil Sampling* SOP (**Worksheet #21** and **Attachment 2**).

At each RBA, 100 percent of the accessible surface (i.e., ground level surface) will be scanned for gamma activity using the instruments and procedures specified in Appendix C of the Parcel G Work Plan. Both gross gamma and gamma spectral measurements will be collected simultaneously during the gamma scan. Gamma scan measurements will be reviewed and accepted as described in Appendix C of the Parcel G Work Plan.

Fifty soil samples, consisting of 25 surface and 25 subsurface soil samples will be collected from each of RBA-1, RBA-2, RBA-3, and RBA-4 (for a total of 200 samples), and 25 surface and 25 subsurface soil samples will be collected from the offsite RBA. The sampling design and rationale are described in detail in Appendix C of the Parcel G Work Plan and summarized in **Worksheet #17**.

Building Investigation and Remediation

Buildings will be divided into SUs, and the size and boundary of the SUs will be based on the previous plans and reports (**Worksheet #17**). BMPs will be used to identify boundaries of SUs based on previous TtEC reports (e.g., survey reports, drawings, and sketches) and field observations. Upon receipt of survey instruments for the building investigations and completion of performance checks, background measurements will be obtained in the RBA for each instrument and on each surface type (e.g., concrete, wood, and sheet rock) that is also present in the SUs. The background measurements will consist of alpha-beta scanning and a minimum of 18 static measurements on each surface to match the number performed in each SU.

SAP Worksheet #14—Summary of Project Tasks (continued)

Radiological investigations at these SUs will be conducted to include the following:

- Alpha-beta scan of surfaces and a preliminary data review.
- Collection of systematic alpha-beta static and swipe measurements and preliminary data review. A minimum of 18 static alpha-beta static measurements will be taken in each SU.
- Collection of biased alpha-beta static and swipe measurements where necessary based on the alpha-beta scan measurements, and preliminary data review.
- Delineation and remediation of residual contamination, if present.
- Collection of building material samples, if necessary.

The building investigation activities, including scanning instrumentation, are presented in detail in the Parcel G Work Plan. A summary of the survey design and rationale for the building investigation is included **Worksheet #17**.

Assessment of Residual Materials and Equipment

Several buildings contain residual materials and equipment from past operations, such as piping, ventilation, shelving, or machinery, that will undergo radioactivity surveys in accordance with Appendix D of the Parcel G Work Plan. These surveys may include a combination of surface scans, static measurements, swipe samples, and material samples. Where possible, sampling or survey points accessed during previous surveys will be used as a starting point. Surveys of impacted building material and equipment will be incorporated into the building SU. After data evaluation, disposition decisions, and subsequent investigation of the surfaces below the materials and equipment, will be coordinated with the Navy.

Remediation of Contaminated Building Surfaces

Following the identification and characterization of contaminated building surfaces, remediation of building surfaces may be performed to ensure that residual radioactivity meets the Parcel G ROD RAO. Specific remediation or decontamination techniques will depend on contaminant, type of surface, and other site-specific factors. Types of decontamination that may be performed include concrete scarifying or scabbling, application of strippable surface coatings, and bulk removal of building components. Remediation will be conducted in building areas with activity that exceed RGs and background. Confirmation measurements will be collected where remediation is performed to verify that contamination has been removed.

Decontamination and Release of Equipment and Tools

Decontamination of mobilized materials and equipment will be conducted at completion of fieldwork. Disposable equipment will be used whenever applicable and will be disposed of immediately after use. Numerous decontamination methods are available for use. If practical, manual decontamination methods should be used. Abrasive methods may be necessary if areas of fixed contamination are identified. Chemical decontamination can also be accomplished by using detergents for nonporous surfaces with contamination present. Chemicals should be selected for decontamination that will minimize the creation of mixed waste. Decontamination activities will be conducted as described in Appendix D of the Parcel G Work Plan.

Management of Investigation-derived Waste

It is anticipated that the following waste streams will be generated and managed as indicated in the Parcel G Work Plan.

SAP Worksheet #14—Summary of Project Tasks (continued)

Site Restoration and Demobilization

The open excavations will be backfilled with the excavated soil upon concurrence from RASO. The excavated material will be returned to the same trench from which the material originated. If additional backfill is required to complete backfill requirements, DTSC's guidance, *Information Advisory Clean Imported Fill Material*, must be used (DTSC, 2001). If the trench excavations are waterlogged, crushed rock or gravel will be placed as bridging material. With Navy concurrence, radiologically cleared recycled fill materials may be used for backfill. The backfill

will be compacted to 90 percent relative density by test method ASTM International D1557. Once the excavated areas have been backfilled, the durable cover will be repaired “in kind” to match pre-excavation action conditions.

Deconstruction of Radiological Screening Yard Pads

Following completion of radiological screening and with Navy approval, the RSY pads will be deconstructed. Before deconstruction, the RSY pads will be radiologically screened and released. The area will be down-posted for the deconstruction activities. The RSY pad material will be consolidated onsite for offsite disposal at an approved disposal facility. If the RSY pad buffer material cannot be reused onsite, it will be disposed offsite at an approved disposal facility as indicated in the Parcel G Work Plan. Following deconstruction, the area will be restored to pre-removal action conditions.

Demobilization

Demobilization will consist of surveying, decontaminating, and removing equipment and materials used during the investigations, cleaning the project site, inspecting the site, and removing temporary facilities. Demobilization activities will also involve collection and disposal of contaminated materials, including decontamination water and disposable equipment for which decontamination is inappropriate.

Data Management, Verification, and Validation

Data Management

Radiological survey and environmental data will be maintained in accordance with Appendix D of the Parcel G Work Plan and **Worksheet #29**. Analytical data will be uploaded into the Navy’s centralized database (Naval Installation Restoration Information Solution) and will be included in final reports.

Data Verification

A Senior QA/QC manager with knowledge of radiological QA/QC will be present in the field for the duration of soil confirmation sampling activities. The QA/QC manager’s sole responsibility will be to ensure that the QC measures in the project plans are performed. The QA/QC manager will maintain all QA/QC records for review and provide copies in the final report.

The contractor will conduct weekly QC meetings to keep Navy personnel informed of field progress. The contractor will prepare all meeting materials, including agenda, figures, data, and look-ahead calendar, and provide copies to all participants 24 hours in advance of the meeting. Meeting minutes will be provided to the Navy within 48 hours of the meeting.

Additionally, the Navy has contracted an independent, third-party contractor to oversee and monitor all field activities and ensure that the activities are in compliance with the Parcel G Work Plan and this SAP.

Additional details regarding data verification are presented in **Worksheets #36-36** and **#37**.

SAP Worksheet #14—Summary of Project Tasks (continued)

Data Validation

Analytical data validation will be conducted by an independent third-party data validation subcontractor in accordance with **Worksheets #34**-**#36** and consistent with Navy Environmental Work Instruction No. 1, *Data Validation Guidelines for Chemical Analysis of Environmental Samples* (NAVFAC SW, 2001), *Multi-Agency Radiological Laboratory Analytical Protocols Manual* (MARLAP) (USEPA et al., 2004), and *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM)" (USEPA et al., 2000). *USEPA National Functional Guidelines for Inorganic Superfund Data Review* (ISM02.2) (USEPA, 2017) may also be applicable.

The data validation findings are summarized in a data validation report. The report content will include an introduction that includes validation guidance used, a summary of the QC elements reviewed, a description of deficiencies, and a summary of the data qualification.

Data Evaluation and Reporting

Reference Background Area Investigation

Various types of radiological data will be collected from multiple RBAs, representing soils with potentially different distributions of naturally occurring and fallout radionuclides. Gamma scan data and analytical sample results will be evaluated as detailed in Appendix C of the Parcel G Work Plan. Analytical data (i.e., soil sample results) will be compiled and validated in accordance with this SAP.

Following completion of RBA soil data evaluation, a report will be prepared to include a summary of the field activities, any deviations from the work plan, results of gamma scan surveys, and analytical and geotechnical data evaluation (including full data packages from the analytical laboratory and third-party data validation reports), along with the results of the data evaluation. Based on the statistical evaluations, the report will include recommendations for combining similar data sets, and recommendations for selecting values or data sets representing background in soil, and conditions identifying situations when specific values or data sets may not be appropriate. Information from other San Francisco Bay Area radiological background studies may be referenced in the report as appropriate. If additional areas are selected for sampling, if other background data sets are identified, or if the U.S. Geological Survey is involved and provides input, details and justification will be provided in the report. The draft report will be submitted for regulatory review, and meetings will be held to discuss the results and facilitate consensus on appropriate background values prior to finalizing the report.

Soil and Building Investigation

Data from the radiological investigation will be evaluated to determine whether the site conditions are compliant with the Parcel G ROD RAO. The details pertaining to the data evaluation process are summarized below and presented in detail in the Parcel G Work Plan.

Figures 11-12 and **11-13** present an overview of how decisions for soil and building data, respectively, are combined to draw a conclusion on compliance with the Parcel G ROD RAO. Each sample and static measurement result will be compared to the corresponding RG. If the residual ROC concentrations are below the Parcel G ROD RGs or are shown to be NORM or anthropogenic background, then the site conditions are compliant with the Parcel G ROD RAO.

SAP Worksheet #14—Summary of Project Tasks (continued)

Radiological surveys will include scan measurements of accessible surfaces combined with collection and analysis of samples and static measurements on building interior surfaces. Scan measurements are used to identify potential areas of elevated radioactivity for investigation using biased samples and static measurements and are not used to directly demonstrate compliance with the Parcel G ROD RAO. Sample and static measurement results at systematic, random, and biased locations are used to evaluate compliance with the Parcel G ROD RAO. A separate compliance decision will be made for each ROC for each sample and static measurement.

If the investigation results demonstrate that there are no exceedances determined from a point-by-point comparison with the statistically-based[9] RGs at agreed upon statistical confidence levels, or that residual ROC concentrations are NORM or anthropogenic background, then a RACR will be developed. If the investigation results demonstrate exceedances of the RGs determined from a point-by-point comparison with the statistically based[9] RGs at agreed upon statistical confidence levels and are not shown to be NORM or anthropogenic background, remediation will be conducted.

Results of radiological investigations for buildings and TUs/SUs complying with the Parcel G ROD RAO will be documented in a RACR, and the buildings and TUs/SUs will be recommended for unrestricted radiological release. The RACR will describe the results of the investigation, include an air monitoring report to evaluate dust and radiological data collected, provide visualizations of spatially correlated data, describe any remediation performed, compare the distribution of data from sites with applicable reference area data, and provide a demonstration that site conditions are compliant with the Parcel G ROD RAO through the use of multiple lines of evidence including application of statistical testing with agreed upon statistical confidence levels on the background data. The final status survey results[10], including a comparison to background and discussion of remedial activities performed as part of the investigation, will be included as an attachment to the RACR.

The reports generated from work outlined in this SAP will be submitted as preliminary draft, draft, draft final, and final versions. The Navy will be provided with each version for review and comment, and documents will be reviewed and approved by the Navy prior to submittal to regulatory agencies. Response to comment (RTC) matrices will be prepared for each comment set received. The RTCs will be used at each review step to facilitate concurrence of responses.

[9] The RGs are statistically based because they are increments above a statistical background.

[10] Reported radiological results will, at a minimum, include count times, results, counting uncertainty, and total propagated uncertainty.

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SAP Worksheet #15a—Reference Limits and Evaluation Soil Gamma Spectroscopy

Matrix: Soil

Analytical Group: Radiological (gamma spectroscopy) – USEPA Method 901.1

Analyte	CAS	Project Remediation Goal[a] (pCi/g)	Project Remediation Goal Reference	Project QL Goal[b] (pCi/g)	Laboratory-Specific Limits[c,d,e,f,g]
					MDC (pCi/g)
^{137}Cs	10045-97-3	0.113	ROD	0.05	0.05
^{226}Ra[h]	13982-63-3	1.0	ROD	0.1	0.1
Bismuth-214 (^{214}Bi)	14913-49-6	none	--	0.1	0.1
Lead-214 (^{214}Pb)	15067-28-4	none	--	0.1	0.1
Potassium-40 (^{40}K)	13966-00-2	none	--	0.5	0.5
Actinium-228 (^{228}Ac)	14331-83-0	none	--	0.3	0.3
Bismuth-212 (^{212}Bi)	14913-49-6	none	--	1.0	1.0
^{212}Pb	15092-94-1	none	--	0.1	0.1
Americium-241 (^{241}Am)	14596-10-2	none	--	0.3	0.3
Protactinium-234 (^{234}Pa)	15100-28-4	none	--	0.75	0.75
^{232}Th	7440-29-1	1.69	ROD	0.3	0.3
Thallium-208 (^{208}Tl)	14913-50-9	none	--	0.1	0.1

Notes:

a The project RGs are based on those provided in the Parcel G ROD, (Navy, 2009). The RGs will be applied as concentrations above background.

b Project Quantitation Limit (QL) goals for individual samples are equal to the MDC and will be a maximum of 90 percent of the RG.

c Results for non-aqueous samples are reported on a dry-weight basis.

d The MDC is an estimate of the smallest true activity (or activity concentration) of an analyte in a sample that results in a 95 percent probability of detection, given a detection criterion that includes a 5 percent probability of false detection in an analyte-free sample. MDCs may vary from sample to sample depending on the composition of the sample matrix. Any changes to these limits that affect the project SAP objectives must be approved by the Navy RPM and QAO in writing in advance of sample testing.

e Gamma spectroscopy analyses will be based on meeting the MDCs for ^{137}Cs and ^{226}Ra. MDCs for other radionuclides analyzed by gamma spectroscopy are not required to be achieved unless specifically requested on the applicable contaminant of concern. All detected radionuclides will be reported by the laboratory.

f Daughter products and naturally occurring isotopes will be reported in the gamma spectroscopy results, which may include, ^{40}K, ^{208}Tl, ^{212}Bi, ^{212}Pb, ^{214}Bi, ^{214}Pb, radium-223, radium-224, thorium-227, ^{228}Ac, Thorium-228 (^{228}Th), Protactinium-231, ^{234}Pa, Protactinium-234m.

g The SOPs reflect standard method MDCs that are the default values if a project does not specify a site-specific detection limit. The MDCs listed in this worksheet can be achieved with larger aliquots or longer count times within the constraints of the method in order to achieve project objectives. MDC is the minimum detectable concentration, which is an equivalent calculation to the minimum detectable activity (MDA).

h ^{226}Ra background will be established as described in this SAP and the Parcel G Work Plan. The ^{214}Bi 609 kiloelectron volt (keV) energy peak will be used to quantify ^{226}Ra following a 21-day in-growth period.

CAS = Chemical Abstracts Service

SAP Worksheet #15b—Reference Limits and Evaluation Soil Alpha Spectroscopy

Matrix: Soil

Analytical Group: Radiological (alpha spectroscopy) – United States Department of Energy (USDOE) Method HASL-300 A-01-R

Analyte	CAS	Project Remediation Goal[a] (pCi/g)	Project Remediation Goal Reference	Project QL Goal[b] (pCi/g)	Laboratory-Specific Limits[c, d, e]
					MDC (pCi/g)
^{226}Ra[f]	13982-63-3	1.0	ROD	0.1	0.1
^{241}Am	14596-10-2	none	--	0.5	0.5
Plutonium-238 (^{238}Pu)	13981-16-3	none	--	0.5	0.5
$^{239/240}Pu$[g]	15117-48-3	2.59	ROD	0.5	0.5
^{234}U	13966-29-5	none	--	0.5	0.5
$^{235/236}U$[h]	15117-96-1	0.195	ROD	0.1	0.1
^{238}U	7440-61-1	None	--	0.5	0.5
^{228}Th	14274-82-9	None	--	1.0	1.0
^{230}Th	14269-63-7	None	--	0.5	0.5
^{232}Th[i]	7440-29-1	1.69	ROD	1.0	1.0

Notes:

[a] The RGs are based on those provided in the Parcel G ROD (Navy, 2009). The RGs will be applied as concentrations above background.

[b] Project QL goals for individual samples are equal to the MDC and will be a maximum of 90 percent of the RG.

[c] Results for non-aqueous samples are reported on a dry-weight basis.

[d] The MDC is an estimate of the smallest true activity (or activity concentration) of an analyte in a sample that results in a 95 percent probability of detection, given a detection criterion that includes a 5 percent probability of false-detection in an analyte-free sample. MDCs may vary from sample to sample depending on the composition of the sample matrix. Any changes to these limits that affect the project SAP objectives, must be approved by the Navy RPM and QAO in writing in advance of sample testing.

[e] The SOPs reflect standard method MDCs that are the default values if a project does not specify a site-specific detection limit. The MDC listed in this worksheet can be achieved with larger aliquots or longer count times within the constraints of the method in order to achieve project objectives. MDC is the minimum detectable concentration, which is an equivalent calculation to the MDA.

[f] Where possible, isotopic analysis for ^{226}Ra will be performed using the same dissolution/digestion as ^{238}U to ensure comparability of results. If analysis of ^{226}Ra is not possible due to interferences, radon emanation (**Worksheet #15d**) will be performed. All detected radium isotopes will be reported.

[g] ^{239}Pu is listed in the above table as $^{239/240}Pu$ because the alpha energy peaks for the isotope of plutonium cannot be separated in alpha spectroscopy. Therefore, the laboratory will report as listed above in the table. All detected plutonium isotopes will be reported.

[h] ^{235}U is listed in the above table as $^{235/236}U$ because the alpha energy peaks for the isotope of uranium cannot be separated in alpha spectroscopy. Therefore, the laboratory will report as listed above in the table. All detected uranium isotopes will be reported.

[I] All detected thorium isotopes will be reported.

SAP Worksheet #15c—Reference Limits and Evaluation Soil Gas Flow Proportional Counting

Matrix: Soil

Analytical Group: Radiological (GFPC) – USEPA Method 905.0 mod

Analyte	CAS	Project Remediation Goal[a] (pCi/g)	Project Remediation Goal Reference	Project QL Goal[b] (pCi/g)	Laboratory-Specific Limits[c,d,e]
					MDC (pCi/g)
^{90}Sr	10098-97-2	0.331	ROD	0.15	0.15

Notes:

[a] The RGs are based on those provided in the Parcel G ROD, (Navy, 2009). The RGs will be applied as concentrations above background.

[b] Project QL goals for individual samples are equal to the MDC and will be a maximum of 90 percent of the RG.

[c] Results for non-aqueous samples are reported on a dry-weight basis.

[d] The MDC is an estimate of the smallest true activity (or activity concentration) of an analyte in a sample that ensures a 95 percent probability of detection, give a detection criterion that includes a 5 percent probability of detection in an analyte-free sample. MDCs may vary from sample to sample depending on the composition of the sample matrix. Any changes to these limits that affect the project SAP objectives must be approved by the Navy RPM and QAO in writing in advance of sample testing.

[e] The SOPs reflect standard method MDCs that are the default values if a project does not specify a site-specific detection limit. The MDC listed in this worksheet can be achieved with larger aliquots or longer count times within the constraints of the method in order to achieve project objectives. MDC is the minimum detectable concentration, which is an equivalent calculation to the MDA.

SAP Worksheet #15d—Reference Limits and Evaluation Soil Radon Emanation

Matrix: Soil

Analytical Group: Radiological (Radon Emanation) – USEPA Method 903.1 mod

Analyte	CAS	Project Remediation Goal [a] (pCi/g)	Project Remediation Goal Reference[a]	Project QL Goal[b] (pCi/g)	Laboratory-Specific Limits[c,d, e]
					MDC (pCi/g)
^{226}Ra[e]	13982-63-3	1.0	ROD	0.1	0.1

Notes:

a The RGs are based on those provided in the Parcel G ROD, (Navy, 2009). The RGs will be applied as concentrations above background.

b The Project QL goals for individual samples are equal to the MDC and will be a maximum of 90 percent of the RG.

c Results for non-aqueous samples are reported on a dry-weight basis.

d The MDC is an estimate of the smallest true activity (or activity concentration) of an analyte in a sample that results in s a 95 percent probability of detection, give a detection criterion that includes a 5 percent probability of false detection in an analyte-free sample. MDCs may vary from sample to sample depending on the composition of the sample matrix. Any changes to these limits that affect the project SAP objectives must be approved by the Navy RPM and QAO in writing in advance of sample testing.

e The SOPs reflect standard method MDCs that are the default values if a project does not specify a site-specific detection limit. The MDC listed above can be achieved with larger aliquots or longer count times within the constraints of the method in order to achieve project objectives. MDC is the minimum detectable concentration, which is an equivalent calculation to the MDA.

f ^{226}Ra background will be established as described in the Parcel G Work Plan.

SAP Worksheet #15e—Reference Limits and Evaluation Water Gamma Spectroscopy

Matrix: Water (for field blanks only)

Analytical Group: Radiological (gamma spectroscopy) – USEPA Method 901.1

Analyte	CAS	Project Remediation Goal[a] (pCi/L)	Project Remediation Goal Reference	Project QL Goal[b] (pCi/L)	Laboratory-Specific Limits[c,d]
					MDC (pCi/L)
^{137}Cs	10045-97-3	none	--	15	15
^{226}Ra	13982-63-3	none	--	75	75
^{214}Bi	14913-49-6	none	--	75	75
^{214}Pb	15067-28-4	none	--	75	75
^{40}K	13966-00-2	none	--	150	150
^{228}Ac	14331-83-0	none	--	150	150
^{212}Bi	14913-49-6	none	--	300	300
^{212}Pb	15092-94-1	none	--	30	30
^{241}Am	14596-10-2	none	--	75	75
^{60}Co	10198-40-0	none	--	30	30
^{234}Pa	15100-28-4	none	--	150	150
^{232}Th	7440-29-1	none	--	450	450

Notes:

[a] The RGs are not applicable for this matrix (i.e., field blanks)
[b] Project QL goals are equal to the MDC.
[c] The MDC is an estimate of the smallest true activity (or activity concentration) of an analyte in a sample that ensures a 95 percent probability of detection, give a detection criterion that ensures on a 5 percent probability of detection in an analyte-free sample. MDCs may vary from sample to sample depending on the composition of the sample matrix. Any changes to these limits that affect the project SAP objectives must be approved by the Navy RPM and QAO in advance of sample testing.
[d] An MDC at or less than the value listed must be achieved for ^{137}Cs and ^{226}Ra for all samples for this project. MDCs for other radionuclides analyzed by gamma spectroscopy are not required to be achieved unless specifically requested on the applicable contaminant of concern.

pCi/L = picocurie(s) per liter

SAP Worksheet #15f—Reference Limits and Evaluation Water Alpha Spectroscopy

Matrix: Water (for field blanks only)

Analytical Group: Radiological (alpha spectroscopy) – USDOE Method HASL-300 A-01-R

Analyte	CAS	Project Remediation Goal[a] (pCi/L)	Project Remediation Goal Reference	Project QL Goal[b] (pCi/L)	Laboratory-Specific Limits[c]
					MDC (pCi/L)
^{241}Am	14596-10-2	none	--	1.0	1.0
^{238}Pu	13981-16-3	none	--	1.0	1.0
$^{239/240}$Pu[d]	15117-48-3	none	--	1.0	1.0
^{226}Ra [f]	13982-63-3	none	--	1.0	1.0
^{234}U	13966-29-5	none	--	1.0	1.0
$^{235/236}$U[e]	15117-96-1	none	--	1.0	1.0
^{238}U	7440-61-1	none	--	1.0	1.0
^{228}Th	14274-82-9	none	--	1.0	1.0
^{230}Th	14269-63-7	none	--	1.0	1.0
^{232}Th	7440-29-1	none	--	1.0	1.0

Notes:

a The RGs are not applicable for this matrix (i.e., field blanks).

b Project QL goals are equal to the MDC.

c The MDC is an estimate of the smallest true activity (or activity concentration) of an analyte in a sample that ensures a 95 percent probability of detection, give a detection criterion that ensures on a 5 percent probability of detection in an analyte-free sample. MDCs may vary from sample to sample depending on the composition of the sample matrix. Any changes to these limits that affect the project SAP objectives must be approved by the Navy RPM and QAO in advance of sample testing.

d ^{239}Pu is listed in the above table as $^{239/240}$Pu because the alpha energy peaks for the isotope of plutonium cannot be separated in alpha spectroscopy. Therefore, the laboratory will report as listed above in the table.

e ^{235}U is listed in the above table as $^{235/236}$U because the alpha energy peaks for the isotope of plutonium cannot be separated in alpha spectroscopy. Therefore, the laboratory will report as listed above in the table.

f Where possible, isotopic analysis for ^{226}Ra will be performed using the same dissolution/digestion as ^{238}U to ensure comparability of results. If analysis of ^{226}Ra is not possible due to interferences, radon emanation (**Worksheet #15h**) will be performed.

SAP Worksheet #15g—Reference Limits and Evaluation Water Gas Flow Proportional Counting

Matrix: Water (for field blanks only)

Analytical Group: Radiological (GFPC) – USEPA Method 905.0 mod

Analyte	CAS	Project Remediation Goal[a] (pCi/L)	Project Remediation Goal Reference	Project QL Goal[b] (pCi/L)	Laboratory-Specific Limits[c]
					MDC (pCi/L)
^{90}Sr	10098-97-2	none	--	2.0	2.0

Notes:

[a] The RGs are not applicable for this matrix (i.e., field blanks).

[b] Project QL goals for individual samples are equal to the MDC and will be a maximum of 90 percent of the RG.

[c] The MDC is an estimate of the smallest true activity (or activity concentration) of an analyte in a sample that results a 95 percent probability of detection, give a detection criterion that includes a 5 percent probability of false detection in an analyte-free sample. MDCs may vary from sample to sample depending on the composition of the sample matrix. Any changes to these limits that affect the project SAP objectives must be approved by the NAVFAC Southwest RPM and QAO in writing in advance of sample testing.

SAP Worksheet #15h—Reference Limits and Evaluation Water Radon Emanation

Matrix: Water (for field blanks only)

Analytical Group: Radiological (Radon Emanation) – USEPA Method 903.1 mod

Analyte	CAS	Project Remediation Goal (pCi/g)	Project Remediation Goal Reference	Project QL Goal[b] (pCi/L)	Laboratory-Specific Limits[c]
					MDC (pCi/L)
^{226}Ra	13982-63-3	None	--	0.1	0.1

Notes:

[a] The RGs are based on those provided in the Parcel G ROD, (Navy, 2009).

[b] The Project QL goals are equal to the MDC.

[c] The MDC is an estimate of the smallest true activity (or activity concentration) of an analyte in a sample that ensures a 95 percent probability of detection, give a detection criterion that ensures on a 5 percent probability of detection in an analyte-free sample. MDCs may vary from sample to sample depending on the composition of the sample matrix. Any changes to these limits that affect the project SAP objectives must be approved by the Navy RPM and QAO in advance of sample testing.

SAP Worksheet #16—Project Schedule/Timeline

Activities	Organization	Dates: Anticipated Date of Initiation	Dates: Anticipated Date of Completion	Deliverable
Draft SAP preparation	CH2M	June 2018	July 2018	Draft SAP
Navy BRAC/RASO SAP review	Navy BRAC and RASO	July 2018	August 2018	Comments and responses
Navy QAO SAP review	Navy QAO	August 2018	September 2018	Comments and responses, Navy Chemist signature
Regulatory review	USEPA, DTSC, CDPH, City of San Francisco	September 2018	October 2018	Comments and responses
Draft Final SAP	Navy and regulatory agencies	October 2018	November 2018	Draft Final SAP, comments and responses
Final SAP	Navy and regulatory agencies	December 2018	January 2019	Final SAP, comments and responses, and signature
Subcontracting and chartering	CH2M	October 2018	February 2019	Subcontractor contracts
Utility locating	CH2M, Perma-Fix, subcontractor	TBD	TBD	None
Field investigations	CH2M, Perma-Fix	TBD	TBD	None
Laboratory analyses, data validation and verification, and data management	GEL, TBD, CH2M	TBD	TBD	Analytical and DV reports
Draft report preparation	CH2M	TBD (within 60 days of completion of the field investigation)	TBD	Draft reports
Navy BRAC/RASO report review	Navy BRAC and RASO	TBD	TBD	Comments and responses
Regulatory report review	USEPA, DTSC, CDPH, City of San Francisco	TBD	TBD	Comments and responses
Report	Navy and regulatory agencies	TBD	TBD	Final report

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SAP Worksheet #17—Sampling and Survey Design and Rationale

The proposed Parcel G Evaluation survey, sampling, and analytical program, as well as the rationale for selecting sample locations, is described below.

Soil Investigation

This section describes the design of radiological investigations, including gamma scanning and soil sample collection in soil. The radiological investigation design and rationale are primarily based on methods, techniques, and instrument systems in the Basewide Radiological Management Plan (TtEC, 2012), with the ultimate requirement to demonstrate compliance with the Parcel G ROD RAO (Navy, 2009).

A two-phased approach is planned for the investigation for surface and subsurface TU soil associated with former sanitary and storm drain lines. The approach is based on a proposal by the regulatory agencies to achieve a high level of confidence that the Parcel G ROD RAO has been met for soil. For Phase 1, 100 percent of soil will be re-excavated and characterized at 33 percent of TUs in Parcel G. Soil sampling and scanning at the remaining 67 percent of TUs will be performed as part of Phase 2 to increase confidence that current site conditions comply with the Parcel G ROD RAO. The Navy will re-excavate 100 percent of Phase 2 TUs if contamination is identified in Phase 1 TUs. For surface soil areas associated with soil from building sites, radiological investigation will be conducted at 28 SUs[11] in Parcel G. The name, size, and boundary of the TUs and SUs will be based on the previous plans and reports.

The ROCs for the soil areas are listed in **Table 17-1,** and RGs are listed in **Worksheets #15a**, **#15b, and #15c**. Samples collected in support of the TU and SU investigation are provided in this worksheet.

Table 17-1. Soil Radionuclides of Concern

Soil Area	Radionuclide of Concern
Former Sanitary Sewer and Storm Drain Lines	^{137}Cs, ^{226}Ra, ^{90}Sr
Former Buildings 317/364/365 Site	^{137}Cs, ^{226}Ra, ^{90}Sr, ^{239}Pu, ^{235}U
Building 351A Crawl Space	^{137}Cs, ^{226}Ra, ^{90}Sr, ^{239}Pu, ^{232}Th

Analysis will be based on the site-specific ROCs listed in **Table 17-1**. All soil samples will be analyzed by gamma spectroscopy for ^{226}Ra and ^{137}Cs with at least 10 percent of randomly selected samples receiving gas flow proportional analysis for ^{90}Sr. Additionally:

- A minimum of 10 percent of systematic soil samples collected from the Former Buildings 317/364/365 Site and adjacent TUs 95, 117, 118, and 153 will be randomly selected for alpha spectroscopy analysis for ^{239}Pu and ^{235}U.
- A minimum of 10 percent of systematic of systematic soil samples collected from the Building 351A Crawl Space and adjacent TUs 97 and 115 will be randomly selected for alpha spectroscopy analysis for ^{239}Pu and ^{232}Th.

[11] Previously, 32 SUs were investigated at Buildings 317/364/365 Former Building Site and Building 351A Crawl Space; however, some SU areas overlapped. For the Buildings 317/364/365 Former Building Site, former SU 22 overlaps TU 153 and will be investigated as part of TU 153. For the Building 351A Crawl Space, former SU R, SU S, and SU U overlap SU M, SU N, and SU O and will be investigated as part of SU M, SU N, and SU O.

- A minimum of 10 percent of systematic of systematic soil samples collected from TUs 107 and 116, adjacent to Building 408, will be randomly selected for alpha spectroscopy analuysis for ^{232}Th.

Gamma spectroscopy data will be reported by the laboratory after a full 21-day in-growth period. If the laboratory results indicate a concentration of ^{226}Ra above the RG

SAP Worksheet #17—Summary and Survey Design and Rationale (continued)

(**Worksheet #15a**), the sample will be analyzed using alpha spectroscopy for uranium isotopes (^{238}U, ^{235}U, and ^{234}U), thorium isotopes (^{232}Th, ^{230}Th, and ^{228}Th), and ^{226}Ra. If the laboratory results indicate concentrations of ^{137}Cs above its RG (**Worksheet #15a**), the sample will be analyzed for ^{90}Sr and by alpha spectroscopy for ^{239}Pu. If the laboratory results indicate the presence of concentrations of ^{90}Sr at or above the respective RG (**Worksheet #15c**), the sample will be analyzed by alpha spectroscopy for ^{239}Pu (**Worksheet #15b**).

Soil samples will be collected on a systematic sampling grid or biased to locations identified by the gamma scanning surveys. The number of systematic soil samples collected will be based on the guidance described in MARSSIM Section 5.5.2.2 (USEPA et al., 2000) using ^{226}Ra as the example basis for calculating the minimum sample frequency. Even if the MARSSIM-recommended or other statistical tests are not used to evaluate site data, these calculations serve as a basis for determining the number of samples per SU to be collected. The number of biased samples will be determined based on results of scan surveys, and a minimum of one biased sample will be collected in every TU and SU.

The methods for calculating the number of samples in an SU are provided in the Parcel G Work Plan. Eighteen samples are recommended as a placeholder until data from the RBA study become available. The minimum number of samples per SU will be developed based on the variability observed in the RBA data. A retrospective power curve will be prepared to demonstrate that the number of samples from each SU was sufficient to meet the project objectives. If necessary, additional samples may be collected to comply with the project objectives.

Phase 1 Trench Unit

Radiological investigations will be conducted on a targeted group of 21 of the 63 TUs associated with former sanitary sewer and storm drain lines (**Figure 11-1** and **Worksheet #18**) to evaluate whether concentrations of ROCs are compliant with the RAO in the Parcel G ROD (Navy, 2009). The former TUs selected for Phase 1 investigation were based on their location adjacent to (i.e., downstream and upstream from) impacted buildings and considered the recommendations from the Radiological Data Evaluation Findings Report (Navy, 2017). The Phase 1 TUs will be re-excavated to the previous excavation limits by making reasonable attempts to ensure accuracy in relocating the former TU boundaries. Excavated material from ESUs and SFUs will be maintained separately (**Worksheet #14**). If the investigation results demonstrate potential exceedances of the RGs and background, the material will be segregated for further evaluation as described in the Parcel G Work Plan. An in situ investigation and/or remediation of the trench sidewalls and floor will be performed prior to backfill. An example Phase 1 TU location is presented on **Figure 17-1**.

Surveys and sampling will be completed through one of the following methods:

- If the automated soil sorting system process is used, a minimum of 18 systematic soil samples will be collected from each ESU or SFU during assay with the soil sorting system. Systematic samples will be collected during a given time period, the frequency of which is determined to provide a systematic distribution of sample collection throughout each ESU or SFU. Systematic samples will be collected by compositing material within each 10-minute interval. Samples will be collected from material moving through the soil sorter before discharging into each bin. A minimum of one biased soil sample will be collected from the soil material that has been discharged to the diverted pile bin.

  If the soil material discharged to the Diverted Pile originates from an SFU and is confirmed to contain contamination, an in situ investigation of the open trench will be performed at the excavation location of the soil. The SFU in situ investigation will include the performance of a gamma scan over the trench surface requiring investigation and additional biased and systematic sampling. The gamma scan will be performed in two stages. The first stage is a 100 percent gamma scan of the accessible areas. Review of the gamma scan data will determine whether further investigation is warranted. If further investigation is not warranted, the

SAP Worksheet #17—Summary and Survey Design and Rationale (continued)

second stage is not necessary, and systematic samples will be collected. If further investigation is warranted, biased samples may be collected. A minimum of 18 systematic soil samples will be collected from each SFU requiring investigation. Each 1,000 m^2 trench SFU will be plotted using Visual Sample Plan (VSP) software (or equivalent) to determine the location of the 18 systematic soil samples. The systematic soil samples will be plotted using a random start triangular or square grid using the VSP software. Soil samples will be collected from the trench surface at a depth of 0 to 6 inches.

The systematic and biased soil samples will be containerized and submitted to the offsite laboratory with appropriate chain-of-custody documentation as described in **Worksheets #21**, **#26**, and **#27**.

- If RSY pads are used for screening soil, excavated TU material (ESUs and SFUs) will be assayed using the RSY process. The objective of the processing activities on the RSY pads is to characterize the material. Material that meets the RGs identified in **Worksheet #15a** will be used as backfill material or shipped offsite as non-LLRW. The RSY pad investigation will include gamma scans over 100 percent of the surface area and systematic and biased soil sampling.

  A minimum of 18 systematic soil samples will be collected. Data obtained during the surface gamma scan surveys, including gross gamma and individual radionuclide spectral measurements, will be analyzed to identify areas where surface radiation levels appear to be greater than the radionuclide-specific investigation levels using regions of interest-peak identification tools. Elevated areas will be noted on a survey map and flagged in the field for verification. Biased samples will be collected from potential areas of elevated activity displaying gamma scan survey results greater than the investigation level, as described in the Parcel G Work Plan. Each 1,000 m^2 RSY pad area will be plotted using VSP software (or equivalent) to determine the location of the 18 systematic soil samples. Soil samples will be collected from the surface at a depth of 0 to 6 inches.

  If gamma scan surveys or soil sampling indicate areas of potentially elevated activity in soil material originating from an SFU, an in situ investigation of the open trench will be performed at the excavation location of the soil. The SFU in situ investigation will include the performance of a gamma scan over the trench surface requiring investigation and additional biased and systematic sampling. The gamma scan will be performed in two stages. The first stage is a 100 percent gamma scan of the accessible areas. Review of the gamma scan data will determine whether further investigation is warranted. If further investigation is not warranted, the second stage is not necessary, and systematic samples will be collected. If further investigation is warranted, biased samples may be collected. A minimum of 18 systematic soil samples will be collected from each SFU requiring investigation. Each 1,000 m^2 trench SFU will be plotted using VSP software (or equivalent) to determine the location of the 18 systematic soil samples. The systematic soil samples will be plotted using a random start triangular or square grid using the VSP software. Soil samples will be collected from the trench surface at a depth of 0 to 6 inches.

  The systematic and biased soil samples will be containerized, labeled, and shipped to the laboratory, as described in **Worksheets #21**, **#26**, and **#27**.

Phase 2 Trench Unit

Radiological investigations will be conducted the remaining 42 TUs in Parcel G associated with former sanitary sewer and storm drain lines (**Figure 11-1** and **Worksheet #18**). Investigations of the Phase 2 TUs will consist of a combination of gamma scan surveys and soil samples.

Each Phase 2 TU will undergo a 100 percent radiological surface gamma scan of accessible areas using an appropriate instrument. Elevated areas will be noted on a survey map and flagged in the field for verification.

SAP Worksheet #17—Summary and Survey Design and Rationale (continued)

Manual scans may be performed to further delineate suspect areas in the TU. Biased samples will be collected from potential areas of elevated activity as described in the Parcel G Work Plan.

Within the backfill of each previous TU boundary, VSP software (or equivalent) will be used to determine the location of the systematic soil boring locations. Each location will be cored down to approximately 6 inches below the depth of previous excavation. Each retrieved core will be scan-surveyed along the entire length of the core. Scan measurement results of the retrieved core will be evaluated to investigate the potential for small areas of elevated activity in the fill material. A sample will be collected from the top 6 inches of material, and a second sample will be collected from the 6 inches of material just below the previous excavation depth. Additionally, a third sample will be collected from the core segment with the highest scan reading that was not already sampled. A total of at least three samples will be collected from each of the 18 borings, for a total of 54 samples per previous TU boundary.

In addition, systematic cores will be placed every 50 linear feet on each trench sidewall in order to collect samples from locations representative of the trench sidewalls. The systematic boring locations will be located approximately 6 inches outside of the previous sidewall excavation limits and will extend 6 inches past the maximum previous excavation depth on both sidewalls in every trench. In the same fashion described in the previous paragraph, core sections will be retrieved, scanned, and sampled such that at least three samples will be collected from each of the boring locations.

An example graphic showing the systematic sample locations and sample locations representing the TU sidewalls is provided on **Figure 17-2**. Systematic soil samples will be located using VSP software (or equivalent). Each TU will be mapped in VSP, such that at a minimum, 18 systematic soil samples will be collected in each TU. The systematic soil samples will be plotted using a random start triangular grid using the VSP software with GPS coordinates for each systematic sample. The systematic and biased soil samples will be containerized and submitted to the offsite laboratory with appropriate chain-of-custody documentation as described in **Worksheets #21**, **#26**, and **#27**

Former Building Site and Crawl Space Survey Unit

Radiological investigations will be conducted at the 28 SUs[12] associated with soil from building sites where only surface soil scanning and sampling were previously conducted (**Figure 11-1** and **Worksheet #18**). Investigation of the building site and crawl space SUs will be performed in a similar fashion as the RSY process, using a combination of surface soil gamma scan surveys and systematic and biased surface soil sampling.

Each SU will undergo a 100 percent surface gamma scan of accessible areas using an appropriate instrument as described in the Parcel G Work Plan. The instrument will be composed of a gamma scintillation detector equipped with spectroscopy coupled to a data logger that logs the resultant data in conjunction with location. Gross gamma and gamma spectra obtained during the surface gamma scan surveys will be analyzed using region of interest peak identification tools for the ROCs (**Table 17-1**). Elevated areas will be noted on a survey map and flagged in the field for verification. Manual scans using a hand-held instrument may be performed to further delineate suspect areas in the SU. Biased samples will be collected from potential areas of elevated activity displaying gamma scan survey results as described in the Parcel G Work Plan.

[12] Previously, 32 SUs were investigated at Buildings 317/364/365 Former Building Site and Building 351A Crawl Space; however, some SU areas overlapped. For the Buildings 317/364/365 Former Building Site, former SU 22 overlaps TU 153 and will be investigated as part of TU 153. For the Building 351A Crawl Space, former SU R, SU S, and SU U overlap SU M, SU N, and SU O and will be investigated as part of SU M, SU N, and SU O.

SAP Worksheet #17—Summary and Survey Design and Rationale (continued)

Following the completion of the gamma scan surveys, systematic soil samples will be located using VSP software (or equivalent). Each SU will be mapped in VSP, such that at a minimum, 18 systematic soil samples will be collected in each SU. The systematic soil samples will be plotted using a random start triangular grid using the VSP software with GPS coordinates for each systematic sample. An example graphic showing the sample locations is provided on **Figure 17-1**. The systematic and biased soil samples will be containerized and submitted to offsite laboratory with appropriate chain-of-custody documentation as described in **Worksheets #21**, **#26**, and **#27**.

At the Former Buildings 317/364/365 Site, SUs 27 (peanut spill) and 28 (LWTS) will be excavated to 2 and 10 feet bgs, respectively, <u>for consistency with the previous excavation boundaries</u> (**Figure 11-1**). The two SUs will be excavated to the original excavation boundaries, as practicable, and gamma scans of the excavated material will be conducted following the process described in **Worksheet #14** for Phase 1 TUs.

Reference Background Area Investigation

The RGs (**Worksheet #15a, #15b**, and **#15c**) are incremental concentrations above background; therefore, RBA samples and measurements will be collected and evaluated to provide generally representative data sets estimating levels in natural background and fallout for the majority of soils at HPNS. The RBA characterization will incorporate three survey techniques: gamma scans, surface soil sampling, and subsurface soil sampling to support data evaluations.

Four of the previously established RBA soil areas with adjustments to the shape and size of the areas will be used for the RBA investigation. These four historical RBAs are still considered non-impacted, representative of much of the soil at HPNS, and suitable for use as RBAs. The four historically non-impacted RBAs are identified as the following:

RBA-1, located on Parcel B
RBA-2, located on Parcel C
RBA-3, located on Parcel D-1
RBA-4, located on Parcel D-2

These four RBAs are shown on **Figure 11-2**. Following characterization of each RBA, a detailed data evaluation will be performed to confirm its suitability as an appropriate RBA.

In addition to the four onsite RBAs, an undisturbed land area within the City of San Francisco's McLaren Park has been selected as a potential location for an offsite RBA (RBA-McLaren). The approximate location of the McLaren Park RBA is shown on **Figure 11-3**. Additional details about McLaren Park are provided in Appendix C of the Parcel G Work Plan. The exact sample locations within McLaren Park may be adjusted based on consultation with the City of San Francisco. Other locations in the San Francisco Bay Area that have been similarly undisturbed may also be used as potential offsite RBA locations. Both surface gamma scan surveys and surface soil samples will be collected from RBA-McLaren to provide a surface soil data set representative of undisturbed surface soil areas. Additional sample locations at McLaren Park or additional RBA locations may be added as necessary to characterize different soil types and depositional areas.

RBA investigations will be conducted at five locations (**Worksheet #18**). **Figures 17-3** through **17-6** show the planned sample locations from RBAs 1 through 4. **Figure 17-7** shows the planned sample locations for the offsite RBA. The investigation of the RBAs will be performed using a combination of gamma scan measurements and surface and subsurface soil sampling. The gamma scan methodology is included in detail in the Parcel G Work Plan. The sampling design is considered representative of the SU sampling designs in terms of sample depths, spatial distribution, and number of samples to be collected.

SAP Worksheet #17—Summary and Survey Design and Rationale (continued)

The minimum number of samples to be collected was determined based on U.S. Nuclear Regulatory Commission (NRC) criteria, NUREG 1505 Section 13.5 that states four reference areas each with between 10 and 20 samples in each should generally be adequate (NRC, 1998). The Parcel G Work Plan provides a number of samples calculation and indicates that a minimum of 18 samples be collected in each SU and each RBA data set. The USEPA has requested that a minimum of 25 samples be collected in each survey unit. Therefore, 25 samples will be a placeholder until data from the RBA study become available. For the RBAs, to satisfy both the NRC criteria and the Parcel G Work Plan, the number of samples in each data set was increased to 25 to ensure that sufficient analytical data will be available. Therefore, 25 surface soil samples and 25 subsurface soil samples will be collected from RBAs 1 through 4 for a total of 100 onsite surface soil samples and 100 onsite subsurface soil samples (**Worksheet #18**). Additionally, 25 surface soil samples and 25 subsurface soil samples will be collected from RBA-McLaren (**Worksheet #18**). Overall, a minimum of 250 soil samples will be collected. Additional samples may be collected, if needed, to characterize observed conditions. This will result in up to 10 RBA data sets of 25 samples each from 5 different RBA locations. Additional data sets may be defined based on soil type or other visual observations of the soil samples.

To simplify the sampling design, the area of each onsite RBA was modified to establish approximately 2,500-ft^2 areas within each of the four historical RBA footprints. For the surface soil sample locations within RBA-1 through RBA-4, a triangular grid will be used to place 25 systematic sample locations. Surface soil samples will be collected from the top 6 inches of soil material at each location for the surface soil data set (**Figure 17-8**). For the purposes of this investigation, onsite surface soil is defined as the uppermost 6-inch interval of soil beneath the asphalt and road base materials installed as part of the durable cover. Within each 2,500-ft^2 surface area, 5 subsurface sampling locations have been established using 5 of the 25 systematic surface sample locations: 1 at the approximate center of each area, and the other 4 located near each of the 4 corners of the area. Subsurface soil samples will be collected from the five sampling locations. Subsurface soil samples will be collected by drilling to a depth of approximately 10 feet bgs from which five subsurface soil samples will be extracted (**Figure 17-8**). The proposed subsurface sample depth intervals are the 1- to 2-foot interval, the 3- to 4-foot interval, the 5- to 6-foot interval, the 7- to 8-foot interval, and the 9- to 10-foot interval. If the geologist determines that lithologic characteristics support modification of the proposed depth increments, additional samples may be collected, or the proposed sample depth may be adjusted to match the lithologic characteristics of the soil column. Additional information is provided in Appendix C of the Parcel G Work Plan.

The planned area for RBA-McLaren, located offsite within McLaren Park, is a square area measuring approximately 75 feet by 75 feet. Within the estimated 5,600-ft^2 surface area (520 m^2), 25 surface sampling locations have been established using a random start systematic triangular grid pattern. Surface soil samples will be from the top 6 inches of soil at each location for the surface soil data set. Subsurface soil samples will be collected from the approximately 1- to 2-foot interval at each location for the subsurface soil data set. Additional samples may be collected from other locations if areas of relatively undisturbed surface soil with varying geological properties are identified during field sampling activities.

Soil sampling will occur at various depths from 0 to 10 feet bgs in accordance with **Worksheet #21** and **Attachment 2**. The soil samples collected from each of the RBAs will be containerized and submitted to the offsite laboratory with appropriate chain-of-custody documentation as described in **Worksheets #21**, **#26**, and **#27**. RBA samples and measurements will be collected and evaluated to establish representative data sets defining natural background and fallout levels of anthropogenic radionuclides, including the full suite of radionuclides listed in **Worksheets #15a**, **#15b**, **#15c**, and **#15d**.

SAP Worksheet #17—Summary and Survey Design and Rationale (continued)

Building Investigation

This section describes the design of radiological investigations, including scan and static measurements on building surfaces. The radiological investigation design and rationale is based on methods, techniques, and instrument systems in the Basewide Radiological Management Plan (TtEC, 2012), with the ultimate requirement being to demonstrate compliance with the Parcel G ROD RAO (Navy, 2009). Previous methodology will be reproduced using BMPs. The ROCs for the building investigation are listed in **Table 17-2**.

Table 17-2. Building Radionuclides of Concern

Building	ROCs	Reference
Building 351	^{137}Cs, ^{226}Ra, ^{90}Sr, ^{232}Th	NAVSEA, 2004
Building 351A	^{137}Cs, ^{239}Pu, ^{226}Ra, ^{90}Sr, ^{232}Th	NAVSEA, 2004
Building 366	^{137}Cs, ^{226}Ra, ^{90}Sr	NAVSEA, 2004
Building 401	^{137}Cs, ^{226}Ra, ^{90}Sr	TtEC, 2009c
Building 408	^{137}Cs, ^{226}Ra, ^{90}Sr, ^{232}Th	NAVSEA, 2004
Building 411	^{137}Cs, ^{60}Co, ^{226}Ra	NAVSEA, 2004
Building 439	^{137}Cs, ^{226}Ra	TtEC, 2009a

Radiological investigations will be conducted on impacted buildings, presented on **Figure 11-4,** to evaluate whether site conditions are compliant with the RAO in the Parcel G ROD (Navy, 2009). The RAO is to prevent receptor exposure to ROCs in concentrations that exceed RGs for all potentially complete exposure pathways. These RGs for structures, equipment, and waste are presented in **Table 17-3** for each of the ROCs identified for the applicable buildings. Also identified for each ROC is the primary particle type emitted during the ROC's decay, or the ROC's radioactive progeny's decay.

Table 17-3. Building Remediation Goals from Parcel G ROD

ROC	Particle Emission(s)	RGs for Structures (dpm/100 cm^2)	RGs for Equipment, Waste (dpm/100 cm^2)
^{137}Cs	β	5,000	5,000
^{60}Co	β	5,000	5,000
^{239}Pu	α	100	100
^{226}Ra	α, β	100	100
^{90}Sr	β	1,000	1,000
^{232}Th	α, β	36.5	1,000

Note:
dpm/100 cm^2 = disintegration(s) per minute per 100 square centimeters

SAP Worksheet #17—Summary and Survey Design and Rationale (continued)

Data collected from building surfaces during this investigation represent the total (fixed and removable) gross activity on the surface, which may result from radiations from multiple radionuclides. Because these survey data are radiation-specific (α and β) but not radionuclide-specific, they cannot be attributed to a particular ROC. Instead, the survey data will be compared to the most restrictive building-specific RG_{α} and RG_{β} as presented in **Table 17-4**. For each building, the RG_{α} is chosen as the structure's lowest RG for an alpha-emitting ROC and the RG_{β} is chosen as the structure's lowest RG for a beta-emitting ROC.

Table 17-4. Building-specific Remediation Goals from Parcel G Work Plan

Building	RG_{α} (dpm/100 cm^2) and ROC	RG_{β} (dpm/100 cm^2) and ROC
Building 351	36.5 (^{232}Th)	1,000 (^{90}Sr)
Building 351A	36.5 (^{232}Th)	1,000 (^{90}Sr)
Building 366	100 (^{226}Ra)	1,000 (^{90}Sr)
Building 401	100 (^{226}Ra)	1,000 (^{90}Sr)
Building 408 slab	36.5 (^{232}Th)	1,000 (^{90}Sr)
Building 411	100 (^{226}Ra)	5,000 (^{137}Cs)
Building 439	100 (^{226}Ra)	5,000 (^{137}Cs)

Parcel G buildings will be divided into identifiable SUs similar in area and nomenclature to the previous final status survey of each building. Generally, impacted floor surfaces and the lower 2 meters of remaining impacted wall surfaces will form Class 1 SUs of no more than 100 m^2 each. The remaining impacted upper wall surfaces and ceilings will generally form the remaining Class 2 SUs of no more than 2,000 m^2 each. Example building Class 1 and Class 2 SUs are presented on **Figure 17-9** and **Figure 17-10, respectively**. Class 3 SUs consist of floor areas in Building 411 and the exterior of Building 366, which were investigated as part of past scoping surveys. Additional information, including SU classifications, is provided in the Parcel G Work Plan. Alpha-beta scan, systematic alpha-beta static and swipe measurements, and biased alpha-beta static and swipe measurements where necessary will be collected from each SU. Building material samples will be collected if necessary.

SUs will be scanned to detect alpha and beta emitters using average scan rates that ensure an alpha probability of detection of approximately 90 percent where feasible, and that the beta scan MDC is less than or equal to the RG_{β} for the building (**Table 17-4**). Scanning will cover a total area of each SU according to its classification. The total surface area of remaining, accessible impacted surfaces to be scanned will be 100 percent in Class 1 SUs, 50 percent in Class 2 SUs, and up to 10 percent in Class 3 SUs. SU scan lanes and static measurement locations will be marked using a consistent reference coordinate system throughout the building. In the absence of other technologies, locations will reference from the southernmost and westernmost points in the SU.

SAP Worksheet #17—Summary and Survey Design and Rationale (continued)

A minimum of 18 alpha-beta static measurements will be taken in each SU. The Parcel G Work Plan provides a number of samples calculations, and the 18 static measurements are recommended as a placeholder until background data become available. The minimum number of static measurements per SU will be developed based on the variability observed in the RBA data. The data quality assessment (DQA) of SU data will include a retrospective power curve (based on the MARSSIM Appendix I guidance) to demonstrate that enough static measurements were performed to meet the project objectives. If necessary, additional static measurements may be performed to comply with the project objectives. Biased static measurements will be used to further investigate areas with potential elevated surface activity as described in the Parcel G Work Plan. Swipe samples will be taken at all locations of systematic and biased static measurements. They will be taken dry, using moderate pressure, over an area of approximately 100 cm^2. Swipe samples will be measured for gross alpha and beta activity using instrumentation described in the Parcel G Work Plan. Swipe samples may be sent offsite if detectable activity exceeds criteria for removable contamination and does not appear to be attributable to radon progeny. Material samples may be collected to further characterize surface materials if scan and static survey measurements exceed RGs. The surface activity on the sample will be compared to the total surface activity measured by the static measurement to assess the removable fraction of surface activity. This information may be used in any dose or risk assessment performed. Building material samples may be collected for offsite analysis to further characterize areas of interest. Remediation will be conducted in building areas with activity that exceed RGs and background as described in **Worksheet #14** and the Parcel G Work Plan.

Background measurements will be obtained in the building RBAs for each instrument and on each surface type (e.g., concrete, wood, and sheet rock) that is also present in the SUs. At least 18 static measurements will be taken on each surface material in the RBA that is representative of the material in the building SUs. The mean instrument- and surface-specific background count rates will be used to update the instrument detection calculations and static count times in the Parcel G Work Plan. Building 404 will serve as the primary RBA in the investigation of Parcel G buildings (**Figure 11-4**). Building 404 is a non-impacted, unoccupied former supply storehouse constructed in 1943 (NAVSEA, 2004). Alternate RBAs may be identified and used if needed based on site-specific conditions identified during the building investigations.

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SAP Worksheet #18—Location-Specific Sampling Methods/SOP Requirements

Sampling Location	Sample ID[a]	Matrix	Depth (feet bgs)[b]	Analytical Group	Number of Samples	Sampling SOP Reference
Phase 1 Trench Unit						
TU69	HPPG-ESU-069A-001; HPPG-SFU-069A-001	Soil	Excavated material; Excavated material representing the sidewalls and bottoms of TU (depth varies depending on historical excavated depth)	Refer to **Worksheets #15a, #15b, #15c, and #15d**	144	See **Worksheet #21**
TU70	HPPG-ESU-070A-001; HPPG-SFU-070A-001				180	
TU76	HPPG-ESU-076A-001; HPPG-SFU-076A-001				198	
TU77	HPPG-ESU-077A-001; HPPG-SFU-077A-001				252	
TU78	HPPG-ESU-078A-001; HPPG-SFU-078A-001				126	
TU79	HPPG-ESU-079A-001; HPPG-SFU-079A-001				162	
TU95	HPPG-ESU-095A-001; HPPG-SFU-095A-001				126	
TU97	HPPG-ESU-097A-001; HPPG-SFU-097A-001				90	
TU98	HPPG-ESU-098A-001; HPPG-SFU-098A-001				90	
TU99	HPPG-ESU-099A-001; HPPG-SFU-099A-001				108	
TU100	HPPG-ESU-100A-001; HPPG-SFU-100A-001				36	

SAP Worksheet #18—Location-Specific Sampling Methods/SOP Requirements (continued)

Sampling Location	Sample ID[a]	Matrix	Depth (feet bgs)[b]	Analytical Group	Number of Samples	Sampling SOP Reference
TU101	HPPG-ESU-101A-001; HPPG-SFU-101A-001	Soil	Excavated material; Excavated material representing the sidewalls and bottoms of TU (depth varies depending on historical excavated depth)	Refer to **Worksheets #15a, #15b, #15c, and #15d**	36	See **Worksheet #21**
TU103	HPPG-ESU-103A-001; HPPG-SFU-103A-001				54	
TU104	HPPG-ESU-104A-001; HPPG-SFU-104A-001				108	
TU107	HPPG-ESU-107A-001; HPPG-SFU-107A-001				54	
TU108	HPPG-ESU-108A-001; HPPG-SFU-108A-001				72	
TU109	HPPG-ESU-109A-001; HPPG-SFU-109A-001				180	
TU115	HPPG-ESU-115A-001; HPPG-SFU-115A-001				54	
TU121	HPPG-ESU-121A-001; HPPG-SFU-121A-001				90	
TU124	HPPG-ESU-124A-001; HPPG-SFU-124A-001				90	
TU153	HPPG-ESU-153A-001; HPPG-SFU-153A-001				90	

SAP Worksheet #18—Location-Specific Sampling Methods/SOP Requirements (continued)

Sampling Location	Sample ID[a]	Matrix	Depth (feet bgs)[b]	Analytical Group	Number of Samples	Sampling SOP Reference
Phase 2 Trench Unit						
TU66	HPPG-ESU-066-0102-01-001; HPPG-SFU-066-0102-01-001	Soil	Backfill of the excavation limits of former TUs (depth varies depending on historical excavated depth); Within 1 meter of the previous sidewallexcavation limits of former TUs every 50 linear feet (depth varies depending on historical excavated depth)	Refer to **Worksheets #15a, #15b, #15c, and #15d**	102	See **Worksheet #21**
TU67	HPPG-ESU-067-0102-01-001; HPPG-SFU-067-0102-01-001				90	
TU68	HPPG-ESU-068-0102-01-001; HPPG-SFU-068-0102-01-001				108	
TU71	HPPG-ESU-071-0102-01-001; HPPG-SFU-071-0102-01-001				162	
TU72	HPPG-ESU-072-0102-01-001; HPPG-SFU-072-0102-01-001				123	
TU73	HPPG-ESU-073-0102-01-001; HPPG-SFU-073-0102-01-001				120	
TU74	HPPG-ESU-074-0102-01-001; HPPG-SFU-074-0102-01-001				78	
TU75	HPPG-ESU-075-0102-01-001; HPPG-SFU-075-0102-01-001				96	
TU80	HPPG-ESU-080-0102-01-001; HPPG-SFU-080-0102-01-001				87	
TU81	HPPG-ESU-081-0102-01-001; HPPG-SFU-081-0102-01-001				120	
TU82	HPPG-ESU-082-0102-01-001; HPPG-SFU-082-0102-01-001				117	

SAP Worksheet #18—Location-Specific Sampling Methods/SOP Requirements (continued)

Sampling Location	Sample ID[a]	Matrix	Depth (feet bgs)[b]	Analytical Group	Number of Samples	Sampling SOP Reference
TU83	HPPG-ESU-083-0102-01-001; HPPG-SFU-083-0102-01-001	Soil	Backfill of the excavation limits of former TUs (depth varies depending on historical excavated depth); Within 1 meter of the previous sidewallexcavation limits of former TUs every 50 linear feet (depth varies depending on historical excavated depth)	Refer to **Worksheets #15a**, **#15b**, **#15c**, and **#15d**	87	See **Worksheet #21**
TU84	HPPG-ESU-084-0102-01-001; HPPG-SFU-084-0102-01-001				84	
TU85	HPPG-ESU-085-0102-01-001; HPPG-SFU-085-0102-01-001				105	
TU86	HPPG-ESU-086-0102-01-001; HPPG-SFU-086-0102-01-001				102	
TU87	HPPG-ESU-087-0102-01-001; HPPG-SFU-087-0102-01-001				99	
TU88	HPPG-ESU-088-0102-01-001; HPPG-SFU-088-0102-01-001				105	
TU89	HPPG-ESU-089-0102-01-001; HPPG-SFU-089-0102-01-001				111	
TU90	HPPG-ESU-090-0102-01-001; HPPG-SFU-090-0102-01-001				75	
TU91	HPPG-ESU-091-0102-01-001; HPPG-SFU-091-0102-01-001				93	
TU92	HPPG-ESU-092-0102-01-001; HPPG-SFU-092-0102-01-001				69	
TU93	HPPG-ESU-093-0102-01-001; HPPG-SFU-093-0102-01-001				84	
TU94	HPPG-ESU-094-0102-01-001; HPPG-SFU-094-0102-01-001				102	

SAP Worksheet #18—Location-Specific Sampling Methods/SOP Requirements (continued)

Sampling Location	Sample ID[a]	Matrix	Depth (feet bgs)[b]	Analytical Group	Number of Samples	Sampling SOP Reference
TU96	HPPG-ESU-096-0102-01-001; HPPG-SFU-096-0102-01-001	Soil	Backfill of the excavation limits of former TUs (depth varies depending on historical excavated depth); Within 1 meter of the previous sidewallexcavation limits of former TUs every 50 linear feet (depth varies depending on historical excavated depth)	Refer to **Worksheets #15a, #15b, #15c, and #15d**	105	See **Worksheet #21**
TU102	HPPG-ESU-102-0102-01-001; HPPG-SFU-102-0102-01-001				66	
TU105	HPPG-ESU-102-0105-01-001; HPPG-SFU-105-0102-01-001				87	
TU106	HPPG-ESU-102-0106-01-001; HPPG-SFU-106-0102-01-001				99	
TU110	HPPG-ESU-110-0102-01-001; HPPG-SFU-110-0102-01-001				99	
TU111	HPPG-ESU-111-0102-01-001; HPPG-SFU-111-0102-01-001				93	
TU112	HPPG-ESU-112-0102-01-001; HPPG-SFU-112-0102-01-001				99	
TU113	HPPG-ESU-113-0102-01-001; HPPG-SFU-113-0102-01-001				99	
TU114	HPPG-ESU-114-0102-01-001; HPPG-SFU-114-0102-01-001				63	
TU116	HPPG-ESU-116-0102-01-001; HPPG-SFU-116-0102-01-001				84	

SAP Worksheet #18—Location-Specific Sampling Methods/SOP Requirements (continued)

Sampling Location	Sample ID[a]	Matrix	Depth (feet bgs)[b]	Analytical Group	Number of Samples	Sampling SOP Reference
TU117	HPPG-ESU-117-0102-01-001; HPPG-SFU-117-0102-01-001				69	

TU118	HPPG-ESU-118-0102-01-001; HPPG-SFU-118-0102-01-001				102	
TU119	HPPG-ESU-119-0102-01-001; HPPG-SFU-119-0102-01-001				99	
TU120	HPPG-ESU-120-0102-01-001; HPPG-SFU-120-0102-01-001				108	
TU122	HPPG-ESU-122-0102-01-001; HPPG-SFU-122-0102-01-001				126	
TU123	HPPG-ESU-123-0102-01-001; HPPG-SFU-123-0102-01-001				126	
TU129	HPPG-ESU-124-0102-01-001; HPPG-SFU-129-0102-01-001				84	
TU151	HPPG-ESU-151-0102-01-001; HPPG-SFU-151-0102-01-001				69	
TU204	HPPG-ESU-204-0102-01-001; HPPG-SFU-204-0102-01-001				111	

SAP Worksheet #18—Location-Specific Sampling Methods/SOP Requirements (continued)

Sampling Location	Sample ID[a]	Matrix	Depth (feet bgs)[b]	Analytical Group	Number of Samples	Sampling SOP Reference
Former Building Site and Crawl Space Soil Survey Unit						
Building 351A Crawl Space	HPPG-351A-SUA0-001	Soil	0 – 0.5	Refer to **Worksheets #15a, #15b, #15c, and #15d**	18	See **Worksheet #21**
	HPPG-351A-SUB0-001				18	
	HPPG-351A-SUC0-001				18	
	HPPG-351A-SUD0-001				18	
	HPPG-351A-SUE0-001				18	

	HPPG-351A-SUF0-001				18	
	HPPG-351A-SUG0-001				18	
	HPPG-351A-SUH0-001				18	
	HPPG-351A-SUI0-001				18	
	HPPG-351A-SUJ0-001				18	
	HPPG-351A-SUK0-001				18	
	HPPG-351A-SUL0-001				18	
	HPPG-351A-SUM0-001				18	
	HPPG-351A-SUN0-001				18	
	HPPG-351A-SUO0-001				18	
	HPPG-351A-SUP0-001				18	
	HPPG-351A-SUT0-001				18	

SAP Worksheet #18—Location-Specific Sampling Methods/SOP Requirements (continued)

Sampling Location	Sample ID[a]	Matrix	Depth (feet bgs)[b]	Analytical Group	Number of Samples	Sampling SOP Reference
Buildings 317/364/365 Site	HPPG-317364365-SU20-001				18	
	HPPG-317364365-SU21-001				18	
	HPPG-317364365-SU23-001				18	
	HPPG-317364365-SU24-001				18	
	HPPG-317364365-SU25-001				18	
	HPPG-317364365-SU26-001				18	
	HPPG-317364365-SU27-001				18	
	HPPG-317364365-SU28-001				18	
	HPPG-317364365-SU29-001				18	
	HPPG-317364365-SU30-001				18	
	HPPG-317364365-SU31-001				18	

SAP Worksheet #18—Location-Specific Sampling Methods/SOP Requirements (continued)

Sampling Location	Sample ID[a]	Matrix	Depth (feet bgs)[b]	Analytical Group	Number of Samples	Sampling SOP Reference
Reference Background Area						
RBA-1	HPRBA1-SS01-000H-0718	Soil	0.0 – 0.5	**Refer to** Worksheets #15a, #15b, #15c, and #15d	**25**	See **Worksheet #21**
	HPRBA1-SB01-0102-0718		1 – 2; 3 – 4; 5 – 6; 7 – 8; 9 - 10		**25**	
RBA-2	HPRBA2-SS0-000H-0718	Soil	0.0 – 0.5		25	
	HPRBA2-SB01-0102-0718		1 – 2; 3 – 4; 5 – 6; 7 – 8; 9 - 10		25	
RBA-3	HPRBA3-SS01-000H-0718	Soil	0.0 – 0.5		25	
	HPRBA3-SB01-0102-0718		1 – 2; 3 – 4; 5 – 6; 7 – 8; 9 - 10		25	
RBA-4	HPRBA4-SS01-000H-0718	Soil	0.0 – 0.5		25	
	HPRBA4-SB01-0102-0718		1 – 2; 3 – 4; 5 – 6; 7 – 8; 9 - 10		25	
RBA-McLaren	HPRBAM-SS01-000H-0718	Soil	0.0 – 0.5		25	
	HPRBAM-SB01-0102-0718		1 – 2		25	
Building Interior Surfaces						
Interior surfaces, as needed[d]	TBD	TBD	NA	Refer to **Worksheets #15a, #15b**	TBD	Refer to Parcel G Work Plan

Notes:

[a] Example sample IDs for sampling have been provided. The site IDs, locations and number of samples collected per site/location are presented in **Worksheets #17** and **#20**. Sample ID instructions are as follows:

Sample IDs from the Phase 1 soil TU investigation will use the following format: AABB-CCC-NNNA-DDD, where AA = facility; BB = site location; CCC = sample type; NNN = former trench unit number; A = alpha-numeric digit of each "batch" (beginning with A, in sequential order, followed by B, C, etc.), DDD = numeric sample digit (beginning with 001, in sequential order, followed by 002, 003, etc.).

Sample IDs from the Phase 2 soil TU investigation will use the following format: AABB-CCC-NNN-EEFF-GG-DDD where AA = facility; BB = site location; CCC = sample type; NNN = former trench unit number; EEFF = two-digit sample interval in feet bgs (EE feet = top of sample interval / FF feet = bottom of sample interval); GG = soil boring number within the TU (beginning with 01, in sequential order); DDD = numeric sample digit (beginning with 001, in sequential order). Note that EE and FF are whole numbers such that a value of "01" represents "1 foot bgs." Also note that surface samples (samples collected from the 0.0- to 0.5-foot depth interval) will be designated as 000H; H for half foot. If the surface sample is collected from a depth other than a half foot, the H designation will still be used; however, a note will be included in the field book to indicate the actual depth sampled).

SAP Worksheet #18—Location-Specific Sampling Methods/SOP Requirements (continued)

For equipment blanks, use the following format: AABBBB-CCXX-XXYY where AA = facility; BBBB = site location; CC = sample type; XX = numerical sample number; DD/MM/YYYY = two-digit day/month and four-digit year.

Sample IDs from the Former Building Site and Crawl Space Soil Survey Unit investigation will use the following format: AABB-CCCC-SUNN-DDDA, where AA = facility, BB = site location; CCCC = Building Site name; SUNN = survey unit number; DDD = numeric digit (beginning with 001, in sequential order, followed by 002, 003, etc.).

Sample IDs from the RBA investigation will use the following format – AABBBB-CCDD-EEFF-MMYY where AA = facility; BBBB = site location; CC = sample type; DD = numerical sample location number; EEFF = two-digit sample interval in feet bgs; and MMYY = the two-digit month and year. For equipment blanks the following format – AABBBB-CCXX-XXYY where AA = facility; BBBB = site location; CC = sample type; XX = numerical sample number; DD/MM/YYYY = two-digit day/month and 4 digit year.

[b] Example depths have been provided for corresponding sample ID. Depths of samples and ID are provided in **Worksheet #14**.

[c] These values represent the minimum number of sample locations Additional biased samples may be collected.

[d] To further characterize site conditions, interior survey measurements may be supplemented by the collection of building material samples or the offsite analysis of swipe samples.

Field QC counts are dependent upon the duration of the field event. Frequency of QA/QC collection is as follows:

- Field Blank - One per water source for each sampling event
- Equipment Blank - For decontaminated equipment, one per type of sampling equipment, per site location; for disposable equipment, one per lot.
- Field duplicates are collected at a frequency of 1 per 10 samples per matrix sent to the laboratory.
- Additional information on sample IDs is presented in **Worksheet #27**

000H = surface sample collected from 0.0- to 0.5-foot depth interval; H for half foot.

HP = Hunters Point

ID = identification

ESU = excavation soil unit

SFU = sidewall floor unit

SB = subsurface sample

SS = surface soil

P = field duplicate identifier

PG = Parcel G

NA= not applicable

SAP Worksheet #19—Field Sampling Requirements

Matrix	Analytical Group	Analytical and Preparation Method/ SOP Reference	Container[a] (number, size, and type)	Sample volume (units)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time
Soil	Radiological (gamma spectroscopy)	USEPA 901.1/ GL-RAD-A-013	Gallon size resealable plastic bag or equivalent container	~200 grams	N/A	180 days (21 days for in-growth for gamma spectroscopy to be completed within 180 days)
Soil	Radiological (alpha spectroscopy)	HASL 300 A-01-R/ GL-RAD-A-011				
Soil	Radiological (GFPC)	USEPA 905.0 mod/ GL-RAD-A-004				
Soil	Radiological (radon emanation)	USEPA 903.1 mod/GL-RAD-A-008				

Notes:

[a] One container for all analyses. Separate containers not required.

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SAP Worksheet #20—Field Quality Control Sample Summary

Matrix	Analytical Group	No. of Sampling Locations	No. of Field Duplicates	No. of MS/MSDs	No. of Field Blanks	No. of Equipment Blanks[a]	No. of Proficiency Test Samples	Total No. of Samples to Lab[b]
Phase 1 TU[b]								
Soil	Radiological (gamma spectroscopy)	2,340	234	NA	NA	TBD	NA	2,574
	Radiological (alpha spectroscopy)	TBD	TBD	NA	NA	TBD	NA	TBD[cd]
	^{226}Ra (radon emanation)	TBD	TBD	NA	NA	TBD	NA	TBD
	^{90}Sr (GFPC)	234	24	NA	NA	TBD	NA	258
Phase 2 TU[b]								
Soil	Radiological (gamma spectroscopy)	4,107	411	NA	NA	TBD	NA	4,518
	Radiological (alpha spectroscopy)	TBD	TBD	NA	NA	TBD	NA	TBD[cd]
	^{226}Ra (radon emanation) [d]	TBD	TBD	NA	NA	TBD	NA	TBD[d]
	^{90}Sr (GFPC)	411	42	NA	NA	TBD	NA	453
Former Building Site and Crawl Space Soil Survey Unit [b]								
Soil	Radiological (gamma spectroscopy)	504	51	NA	NA	TBD	NA	555
	Radiological (alpha spectroscopy)	20	2	NA	NA	TBD	NA	22[bcd]
	^{226}Ra (radon emanation)	TBD	TBD	NA	NA	TBD	NA	TBD[d]
	^{90}Sr (GFPC)	51	6	NA	NA	TBD	NA	57

SAP Worksheet #20—Field Quality Control Sample Summary (continued)

Matrix	Analytical Group	No. of Sampling Locations	No. of Field Duplicates	No. of MS/MSDs	No. of Field Blanks	No. of Equipment Blanks[a]	No. of Proficiency Test Samples	Total No. of Samples to Lab[b]
Reference Background Area								
Soil	Radiological (gamma spectroscopy)	250	25	NA	NA	TBD	NA	275
	Radiological (alpha spectroscopy)	250	25	NA	NA	TBD	NA	275
	^{226}Ra (radon emanation)	250	25	NA	NA	TBD	NA	275
	^{90}Sr (GFPC)	250	25	NA	NA	TBD	NA	275
Building Investigation								
Building Surfaces	Alpha-beta static	18 per SU	TBD[e]	NA	NA	NA	NA	TBD[f]
	Radiological (gamma spectroscopy)	TBD	NA	NA	NA	NA	NA	TBD[g]
	Radiological (alpha spectroscopy)	TBD	NA	NA	NA	NA	NA	TBD[g]

Notes:

[a] Equipment Blank - For decontaminated equipment, one per type of sampling equipment, per site location; for disposable equipment, one per lot.

[b] The minimum number of sampling locations are provided. Additional biased samples may be collected.

[c] The number of samples will be based on the results of the gamma spectroscopy analysis for ^{137}Cs and GFPC analysis for ^{90}Sr, as described in **Worksheets #11 and #17**.

[d] The number of samples will be based on the results of the gamma spectroscopy analysis for ^{226}Ra, as described in **Worksheets #11 and #17**.

[e] QC of radiological survey measurements will be performed in accordance with the Radiation Protection Plan (Appendix D of the Parcel G Work Plan). In addition, field duplicate measurements will be performed on 5 percent of systematic static measurements.

[f] The total number of measurements will be based on the number of SUs within each building. A minimum of 18 static measurements will be collected. Additional biased measurements may be performed.

[g] Samples of building materials may be collected to further investigate areas of interest.

MS/MSD not applicable to radiological testing

TBD = To be determined

SAP Worksheet #21—Project Sampling SOP References

Radiological SOPs are specific to the activities being performed, the companies performing the work, and the radioactive material license used. These SOPs include radiological testing activities such as, radiation dose measurements, personnel monitoring, and radiological postings. Further, each company's SOPs may be different based on the requirements of their radioactive material license. Therefore, a comprehensive list and copies of radiological SOPs will be provided by CH2M and Perma-Fix as Attachment B of the Parcel G Work Plan. The following table includes a list of the CH2M field SOPs that apply to the activities in this SAP. For clarity, a comprehensive list of applicable SOPs for each sampling location are provided in the Parcel G Work Plan and this SAP as appropriate. Refer to **Worksheet #14** for project-specific procedural details.

Title	Date, Revision and/or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Yes/No)	Comments
Soil Sampling	6/2017	CH2M	Hand Auger, Stainless Bowl, Spoon	No	None
Logging of Soil Borings	6/2017	CH2M	Indelible pen, ruler, logbook, spatula, soil color chart, grain size chart, hand lens, Unified Soil Classification System index charts	No	None
Decontamination of Equipment and Samples	6/2017	CH2M	Buckets	No	None
Preparing Field Logbooks	6/2017	CH2M	Logbook and Indelible Pen	No	None
Chain-of-Custody	6/2017	CH2M	chain-of-custody form	No	None
Packaging and Shipping Procedures for Low-Concentration Samples	6/2017	CH2M	Laboratory-supplied coolers	No	None

Notes:

Field SOPs are presented in **Attachment 2**.

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SAP Worksheet #22—Field Equipment Calibration, Maintenance, Testing, and Inspection

<table>
<tr><th>Field Equipment</th><th>Activity</th><th>Frequency</th><th>Acceptance Criteria</th><th>Corrective Action</th><th>Responsible Person</th><th>SOP Reference</th><th>Comments</th></tr>
<tr><td colspan="6">No field instruments for chemical screening will be used for this project.</td><td></td><td></td></tr>
<tr><td rowspan="4">Ludlum Model 2221 Meter (or equivalent) or Osprey Multi-channel analyzer with Bicron 3x5x16 detector (or equivalent); Ludlum Model 2221 Meter (or equivalent) or multi-channel analyzer with Ludlum 44-20 (or equivalent); Ludlum Model 2360 meter (or equivalent) with Ludlum Model 43-37 detector (or equivalent); Ludlum Model 3030 Alpha-Beta Sample Counter (or equivalent); Automated soil sorting system (model to be determined); Surface Contamination Monitor (model to be determined).</td><td>Calibrate at lab featuring Nation Institute of Standards and Technology traceable standards</td><td colspan="3" rowspan="4">Radiological controls portable instrument procedures are described in detail in Attachment B of the Parcel G Work Plan</td><td rowspan="4">Project RSO, Field Team Lead, or qualified designee</td><td rowspan="4">Radiological controls portable instrument procedures are described in detail in Attachment B of the Parcel G Work Plan</td><td rowspan="4">If equipment is deemed inoperable or is malfunctioning, it will be removed from use and replaced.</td></tr>
<tr><td>Efficiency Check</td></tr>
<tr><td>Operational checks and verifications</td></tr>
<tr><td>Maintenance/Inspection</td></tr>
</table>

Notes:
Additional instrumentation may be used as described in the Parcel G Work Plan.

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SAP Worksheet #23—Analytical SOP References

Lab SOP Number[a]	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
GL-LB-E-012	Standard Operating Procedure for Verifying the Maintenance of Sample Integrity, Revision 7, September 2016	N/A	N/A	N/A	GEL	N
GL-RAD-A-004	The Determination of Strontium 89/90 in Water, Soil, Milk, Filters, Vegetation and Tissues, Revision 18, February 2017	Definitive	Soil - Radiological (GFPC)	Gas Flow Proportional Counter	GEL	N
GL-RAD-A-008	The Determination of Radium-226, Revision 15, January 2018	Definitive	Soil - Radiological (Radon Emanation)	Scintillation Counter	GEL	Y, modified to accommodate determination from soil matrix
GL-RAD-A-011	The Isotopic Determination of Americium, Curium, Plutonium, and Uranium, Revision 26, October 2015	Definitive	Soil - Radiological (alpha spectroscopy)	Alpha Spectrometer	GEL	N
GL-RAD-A-013	The Determination of Gamma Isotopes, Revision 26, February 2017	Definitive	Soil - Radiological (gamma spectroscopy)	Gamma Spectrometer	GEL	N
GL-RAD-A-015	Standard Operating Procedure for Digestion of Soil, Revision 10, February 2017	N/A	Soil - Radiological	N/A	GEL	N
GL-RAD-A-038	Standard Operating Procedure for the Isotopic Determination of Thorium, Revision 17, February 2016	Definitive	Soil - Radiological (alpha spectroscopy)	Alpha Spectrometer	GEL	N
GL-RAD-A-046	The Determination of Radium-224 and Radium-226 by Alpha Spectroscopy, Revision 9, July 2016	Definitive	Soil - Radiological (alpha spec)	Alpha Spectrometer	GEL	N
GL-RAD-I-001	Gamma Spectroscopy System Operation, Revision 21, February 2017	N/A	Soil - Radiological (gamma spectroscopy)	Gamma Spectrometer	GEL	N
GL-RAD-I-004	Standard Operating Procedure for Beckman LS 6000/6500	N/A	Soil - Radiological (Radon Emanation)	Scintillation Counter	GEL	N

SAP Worksheet #23—Analytical SOP References (continued)

Lab SOP Number[a]	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
GL-RAD-I-007	Standard Operating Procedure for Ludlum Lucas Cell Counter, Revision 12, March 2017	N/A	Soil - Radiological (Radon Emanation)	Scintillation Counter	GEL	N
GL-RAD-I-009	Standard Operating Procedure for Alpha Spectroscopy System, Revision 15, May 2015	N/A	Soil - Radiological (alpha spectroscopy)	Alpha Spectrometer	GEL	N
GL-RAD-I-010	Procedure for Counting Room Instrumentation Maintenance, Revision 20, July 2014	N/A	Soil - Radiological	N/A	GEL	N
GL-RAD-I-012	Managing Statistical Data in the Radiochemistry Laboratory, Revision 26, April 2016	N/A	Soil - Radiological	N/A	GEL	N
GL-RAD-I-016	Multi-Detector Counter Operating Instructions, GL-RAD-I-016, Revision 10, April 2015	N/A	Soil - Radiological	N/A	GEL	N

Notes:

[a] Laboratory SOPs and the gamma spectroscopy library are provided in **Attachment 3.**

SAP Worksheet #24—Analytical Instrument Calibration

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for CA	SOP Reference[1]
Gamma Spectrometer	Initial Calibration (ICAL) (Energy, efficiency and Full Width at Half Maximum [FWHM] peak resolution)	Prior to initial use, following repair or loss of control and upon incorporation of new or changed instrument settings.	The energy difference should be within 0.05% for all calibration points or within 0.2 keV. Peak energy difference is within 0.1 keV of reference energy for all points. Peak FWHM < 3 keV at 1332 keV. The efficiency difference should be within 8% of the true value for each point unless T.C.C. calibration is performed.	Correct problem, then repeat ICAL.	Analyst/Supervisor	GL-RAD-I-001
	Initial Calibration Verification (ICV)	After ICAL for energy/efficiency and prior to analysis of samples.	Observed peaks of second source standard fall within ± 10% of ICAL value relative to the true value.	Verify second source standard and repeat ICV to check for errors. If that fails, identify and correct problem and repeat ICV or ICAL and ICV as appropriate.		
	Continuing Calibration Verification (CCV) Daily Check	Daily or prior to use. When working with long count times or batch sequences that run more than a day, CCV is performed at the beginning and end of each analytical batch as long as if not longer than a week.	Energy: ±0.5 keV at 60 keV; ± .75 keV at 1332 keV FWHM: ±1.2x at 60 keV; ±1.8x at 662 keV; ±2.3x at 1332 keV Activity Difference: %difference between the source activity and the reported activity ±5%	Correct problem, rerun CCV. If CCV rerun fails, repeat ICAL. Reanalyze all samples since the last successful calibration verification.		
	Background Subtraction Count (BSC) Measurement (Long count for subtracting background from blanks or test sources)	Immediately after ICAL and then performed on at least a monthly basis.	Background count rate of the entire spectrum with ±3σ of the average.	Recount and check control chart for trends. Determine cause, correct problem, re-establish BSC. If background activity has changed, re-establish BSC and reanalyze or qualify all impacted samples since last acceptable BSC.		

	Instrument Contamination Check (ICC) (Short count for controlling gross contamination)	Daily or when working with long count times before and after each analytical batch. Check after counting high activity samples.	No extraneous peaks identified (i.e., no new peaks in the short background spectrum compared to previous spectra); Background count rate of the entire spectrum with ±3σ of the average.	Recount the background. If still out of control, locate and correct problem; reanalyze or qualify all impacted samples since last acceptable ICC. If background activity has changed, re-establish BSC and reanalyze samples.		
Alpha Spectrometer	ICAL (Energy, efficiency, and FWHM peak resolution)	Prior to initial use, following repair or loss of control and upon incorporation of new or changed instrument settings.	3 isotopes within energy range of 3-6 MeV Energy vs. channel slope equation <15 keV per channel. FWHM ≤100 keV for each peak used for calibration. Final peak energy within 20 keV of reference energy Minimum of 3,000 net counts in each peak.	Correct problem, then repeat ICAL.	Analyst/Supervisor	GL-RAD-I-009
	ICV	After ICAL.	FWHM ≤100 keV Each peak within ±20 keV of corresponding calibration peaks in initial energy calibration. Minimum 2,000 net counts. Efficiency within 95% - 105% of ICAL value.	Repeat ICV to check for error. If that fails, identify and correct problem and repeat ICV or ICAL and ICV, as appropriate.		
	CCV (Pulser check)	Pulser verification daily, prior to analysis of samples.	Gross counts within 5% of the average (20-point minimum). FWHM within 10-20 keV. Energy within ± 40 keV of the average (20-point minimum).	Recount and check control chart for trends. Determine cause, correct problem, and repeat CCV and all associated samples since last successful CCV.		
	CCV (Check source)	Monthly source check verification prior to analysis of samples.	FWHM ≤100 keV Each peak within ±30 keV of corresponding calibration peaks in initial energy calibration. Minimum 2,000 net counts. Efficiency within 95% - 105% of ICAL value.	Recount and check control chart for trends. Determine cause, correct problem, and repeat CCV and all associated samples since last successful CCV.		

SAP Worksheet #24—Analytical Instrument Calibration (continued)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for CA	SOP Reference[1]
Alpha Spectrometer	BSC Measurement	Prior to initial use or after ICAL and monthly.	Use a statistical test to determine a change in the background count rate value.	Check control chart for trends and recount. Determine cause, correct problem, re-establish BSC. If background activity has changed, re-establish BSC and reanalyze all impacted samples since last acceptable BSC.	Analyst/Supervisor	GL-RAD-I-009
	ICC	Performed weekly, at minimum, and after counting high activity samples.	Blank ≤3 for blank subtracted (net) activity in all region of influence.	Check control chart for trends and recount. Determine cause and correct problem. If background activity has changed, re-establish BSC and reanalyze all infected samples.		
Scintillation Counter (Radon Emanation)	Initial Calibration - <u>Voltage Plateau</u> (ICALV)	Prior to initial use.	Plot the gross counts on the y-axis and the voltage on the x-axis and determine the "knee" of the plateau. The knee is determined by drawing straight lines along the rising slope and the plateau portions of the curve. The knee is the point where these two lines intersect. The operating voltage should be selected at 50 – 150 volts above the "knee."	Correct problem, then repeat ICAL.	Analyst/Supervisor	GL-RAD-I-004
	ICAL – Cell Constant	Prior to initial use.	Each counting cell is calibrated by spiking a 500-milliliter deionized water sample with known disintegrations per minute of ^{226}Ra activity. The sample is carried through the entire procedure. The procedure is performed 3 separate times to each cell. Calculate cell constant, average and standard deviation from the three runs. Standard deviation needs to be less	Correct problem, then repeat ICAL.		

			than 10 % of the cell constant average.			
	CCV Daily Check	Daily or prior to use, after any instrument maintenance, or whenever a problem is suspected.	Compared to historical laboratory limits	Correct problem, rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification.		

SAP Worksheet #24—Analytical Instrument Calibration (continued)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for CA	SOP Reference1
Gas Flow Proportional Counter	ICALV (separate plateaus determined for alpha and beta activity)	Prior to initial use and after loss of control.	Slope of the plateau less than 5% over a range of 100V.	Correct problem, then repeat ICALV.	Analyst/Supervisor	GL-RAD-I-016
	Initial Calibration - Efficiency (ICALE)	Prior to initial use, after loss of control, and upon incorporation of new or changed instrument settings.	Verify manufacturer’s specifications for detector efficiency for both alpha and beta counting modes using electroplated sources.	Correct problem, then repeat ICALE.		
	ICAL – Cross-talk Factors	Prior to initial use, after loss of control, and upon incorporation of new or changed instrument settings.	Verify manufacturer’s specifications for cross-talk in alpha and beta channels.	Correct problem, then repeat ICALCT.		
	ICAL – Self-Absorption Curve	Prior to initial use, after loss of control, and upon incorporation of new or changed instrument settings.	For each radionuclide of interest (or isotope with similar energy profile), establish mathematical function (curve) of detector efficiency vs. source mass loading. Best fit of data with coefficient of determination (r^2) ≥ 0.9.	Correct problem, then repeat ICALSA.		
	Efficiency Calibration Verification (IECV)	After ICALE for alpha and beta and prior to analysis of samples.	Individual points within ±30% of true value, average of points within ±10% of ICAL value.	Correct problem and verify second source standard. Rerun IECV. If that fails, correct problem and repeat ICALE.		
	CCV	After a counting gas change and daily for short test-source counting intervals.	Within tolerance or control chart limits ± 3% or 3σ of the mean.	Correct problem, rerun calibration verification. If that fails, then repeat ICALE. Reanalyze all samples since the last successful calibration verification.		

Notes:

The specifications in this table meet the requirements of Department of Defense (DoD) *Quality Systems Manual* (QSM) v.5.1.

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SAP Worksheet #25—Analytical Instrument and Equipment Maintenance, Testing, and Inspection

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Gamma spectrometer	Liquid Nitrogen fill	Physical check	Physical check	Weekly	Acceptable background	• Recalibrate • Instrument maintenance • Consult with Technical Director	Analyst/Supervisor	GL-RAD-I-010
Alpha spectrometer	1. Vacuum Pump Oil replacement 2. Filter cleaning on the air intake of the instrument cabinet	1, 2. Physical check	1, 2. Physical check	1. Semi-annually 2. Quarterly	1, 2. Acceptable background and calibration efficiencies	• Recalibrate • Instrument maintenance • Consult with Technical Director	Analyst/Supervisor	GL-RAD-I-010
Gas Flow Proportional Counter	Sample Shelf Cleaning	Physical check	Physical check	Weekly	None applicable	None applicable	Analyst/Supervisor	GL-RAD-I-010
Liquid Scintillation Counter	Window cleaning on Radon Flask Counter	Physical check	Physical check	Weekly	None applicable	None applicable	Analyst/Supervisor	GL-RAD-I-007

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SAP Worksheet #26—Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Field Team/CH2M **Sample Packaging (Personnel/Organization):** Field Team Leader/CH2M or qualified designee **Coordination of Shipment (Personnel/Organization):** Field Team Leader/CH2M **Type of Shipment/Carrier:** Overnight Carrier/ FedEx
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Sample Receipt Staff/GEL Laboratories, LLC **Sample Custody and Storage (Personnel/Organization):** Sample Receipt Staff/GEL Laboratories, LLC **Sample Preparation (Personnel/Organization):** Various chemists and technicians /GEL Laboratories, LLC **Sample Determinative Analysis (Personnel/Organization):** Various chemists and technicians/ GEL Laboratories, LLC
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 90 days from receipt
SAMPLE DISPOSAL
Personnel/Organization: Sample Disposal Staff/GEL Laboratories, LLC, **Number of Days from Analysis:** All laboratory samples and any remaining sample volume will be returned under chain-of-custody for archiving to: Aptim Federal Services Attn: Randall Kilpack/Aptim 200 Fischer Ave. Former Hunters Point Naval Shipyard San Francisco, CA 94124

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SAP Worksheet #27—Sample Custody Requirements

Soil Sample Identification Procedures

Each surface and subsurface RBA sample will be given a unique ID number that is carried through the entire process from sample collection to data reporting (see **Worksheet #18**). The former TUs will be excavated and characterized in "batches" that will be given new unique identifiers at the time of excavation. Excavated material representing the backfill material from former TUs and excavated material representing the sidewalls and bottoms of former TUs will be given a unique ID number that is carried through the entire process of sample collection to data reporting (see **Worksheet #18**).

Samples will be assigned an alpha-numeric identifier that will be tied to the sampling location and sampling depth through a separate logbook that will be maintained in the field by the field sampling personnel. The field sampling personnel's logbook will be kept in addition to the chain-of-custody.

Field Sample Custody Procedures

Field sample custody procedures include sample collection, packaging, shipment, and delivery to the laboratory. Custody of field samples will be maintained and custody transfer will be documented from the time of sample collection through receipt of samples at the analytical laboratory using chain-of-custody and custody seal procedures. These requirements will be fulfilled by the Sample Management Coordinator or qualified designee. Each sample will be considered to be in the sampler's custody if one of the following occurs:

- The sample is in the person's physical possession.
- The sample is in view of the person after that person has taken possession.
- The sample is secured so that no one can tamper with the sample.
- The sample is secured in an area that is restricted to authorized personnel.

Samples will be shipped directly from the field to each analytical laboratory. Samples will be packaged and shipped for offsite analysis in accordance with *SOP Packaging and Shipping Procedures for Low-Concentration Samples* (**Worksheet #21** and **Attachment 2**).

Chain-of-custody Procedures

The chain-of-custody record will document the transfer of sample custody from the time of sample collection to laboratory receipt and will accompany the samples from the field to the analytical laboratory. The requirements for sample labels, custody seals, and chains-of-custody are included in in the *SOP Chain-of-Custody* (**Attachment 2**). A digital sample documentation/tracking program may be used during the execution of the work plan to provide additional confidence in sample recordkeeping and to add efficiencies to the process.

When custody of the samples is relinquished from one party to another, the individuals involved will sign, date, and record the time of transfer on the chain-of-custody record. The chain-of-custody records may consist of an original top copy and two carbonless copies, or the records may be in a pre-populated electronic format. When using the carbonless chain-of-custody format, the original and first copies will be transmitted to the primary analytical laboratory with the samples. The second copy will be retained in project files for the Field Team Leader, Project Chemist, and Database Manager. Field personnel will sign and date the chain-of-custody forms prior to sealing the cooler and shipping the samples. Field personnel will make a copy of the signed form and scan a copy of each chain-of-custody record to be saved electronically in the project files.

The chain-of-custody record will be completed by each field sampling team using waterproof ink. Corrections will be made with a single line-out, the error will be initialed and dated, and then the correct information will be entered. Empty fields on the chain-of-custody record will be crossed out with a single line or "Z'd" out, with the date and signature entered by the field sampling team. If samples are to be delivered to the laboratory by an

SAP Worksheet #27—Sample Custody Requirements (continued)

overnight carrier, the airbill number will be recorded, and the chain-of-custody records will be placed in a waterproof plastic bag and taped to the inside lid of the sample cooler prior to sealing with appropriate secure tape and custody seals. These requirements will be fulfilled by the field sampling personnel.

Custody seals

Custody seals will be placed on the outside of each sample cooler so that the seals must be broken to open. After field samples are placed into coolers, two or more custody seals will be placed on the outside of the cooler prior to shipment or transport. Each custody seal will be initialed and dated by the field sampling team, affixed to the cooler, and taped over using clear strapping tape.

Field Logbook

Field notes will be kept in bound, weatherproof logbooks. Notes will be taken with waterproof, nonerasable ink. Field staff completing separate tasks will keep separate logbooks, as necessary, according to the SOP *Preparing Field Logbooks* **(Worksheet #21** and **Attachment 2**).

Laboratory Sample Custody Procedures

Laboratory sample custody procedures include the receipt of samples, archiving, and disposal. Custody of samples will be maintained and custody transfer will be documented from the time of sample receipt through sample disposal by the analytical laboratory consistent with the analytical laboratory's SOP for maintaining sample integrity (SOP GL-LB-E-012).

The analytical laboratories will have established custody procedures, which include the following:

- Designation of a sample custodian
- Completion by the custodian of the chain-of-custody record, any sample tags, and laboratory request sheets, including documentation of sample condition upon receipt
- Laboratory sample tracking and documentation procedures
- Secure sample storage with the appropriate environment (e.g., refrigerated, dry), consistent with analytical method requirements
- Proper data logging and documentation procedures, including custody of original laboratory records

Upon arrival of the samples at the analytical laboratory, a sample custodian will take custody of the samples, assess the integrity of sample containers, and verify that the information on the sample labels matches the information on the associated chain-of-custody record. The laboratory will restrict access to the storage areas to authorized laboratory personnel only, to prevent unauthorized contact with samples, extracts, or documentation. The sample custodian will maintain security of the samples in accordance with the analytical laboratory SOP.

Soil and field QC water samples will be retained by the laboratory for 90 days after final sample results are reported. Laboratory samples and any remaining field sample volume will be returned under chain-of-custody to HPNS for archiving **(Worksheet #26**).

SAP Worksheet #28a—Laboratory QC Samples Soil Gamma Spectroscopy

Matrix: Soil

Analytical Group: Radiological (gamma spectroscopy)

Analytical Method/SOP Reference: USEPA Method 901.1/GL-RAD-A-013

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for CA	Data Quality Indicator	Measurement Performance Criteria
Method Blank	One per prep batch of 20 or fewer samples of similar matrix or one per day, whichever comes first	No analytes detected < reportable detection limit or less than 5% associated sample activity	Correct problem. If required, re-prepare and reanalyze method blank (MB) and all samples processed with the contaminated blank.	Analyst/ Supervisor	Bias/Contamination	Same as Method/SOP QC Acceptance Limits
Laboratory Control Sample		Recovery Limits: ^{137}Cs: 75-125% ^{60}Co: 75-125% ^{241}Am: 75-125%	Identify problem; if not related to matrix interference, re-reanalyze LCS and all associated batch samples		Accuracy/Bias	
Laboratory Duplicate		RPD ≤25% and/or relative error ratio (RER) ≤1	Correct problem, then re-reanalyze all samples processed with the duplicate		Precision	

Notes:

DoD QSM v5.1 limits do not exist and the laboratory SOP limits will be used.

SAP Worksheet #28b—Laboratory QC Samples Soil Alpha Spectroscopy

Matrix: Soil

Analytical Group: Radiological (alpha spectroscopy)

Analytical Method/SOP Reference: USDOE Method HASL-300 A-01-R/ GL-RAD-A-011

<table>
<tr><th>QC Sample</th><th>Frequency/Number</th><th>Method/SOP QC Acceptance Limits</th><th>Corrective Action</th><th>Person(s) Responsible for CA</th><th>Data Quality Indicator</th><th>Measurement Performance Criteria</th></tr>
<tr><td>Method Blank</td><td rowspan="2">One per prep batch of 20 or fewer samples of similar matrix or one per day, whichever comes first</td><td>No analytes detected > MDC</td><td>Correct problem. If required, re-prepare and reanalyze MB and all samples processed with the contaminated blank.</td><td rowspan="3">Analyst/ Supervisor</td><td>Bias/Contamination</td><td rowspan="3">Same as Method/SOP QC Acceptance Limits</td></tr>
<tr><td>Laboratory Control Sample</td><td>Recovery Limits:
^{241}Am: 75-125%
^{238}Pu: 80-127%
$^{239/240}$Pu: 75-125%
^{238}U: 75-125%
^{226}Ra: 75-125%
^{232}Th: 75 – 125%</td><td>Identify problem; if not related to matrix interference, re-reanalyze LCS and all associated batch samples</td><td>Accuracy/Bias</td></tr>
<tr><td>Tracer</td><td>Per sample, blank, LCS, MS, MSD</td><td>Barium-133 tracer: 15-125%
Plutonium-242 tracer: 15–1250%
Uranium-232 tracer: 15-125%
Thorium-229 tracer: 15–125%</td><td>Truncate tracers above 100% recovery to eliminate low biased results. Re-prepare and reanalyze sample if carrier is low (indicating high biased results) if there is activity in the sample above the reporting limit. No reanalysis if matrix interference is nonconformance during sample preparation</td><td>Accuracy/Bias</td></tr>
</table>

Notes:

DoD QSM v5.1 limits do not exist and the laboratory SOP limits will be used.

SAP Worksheet #28c—Laboratory QC Samples Soil Gas Flow Proportional Counting

Matrix: Soil

Analytical Group: Radiological (GFPC)

Analytical Method/SOP Reference: USEPA Method 905.0 mod/ GL-RAD-A-004

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for CA	Data Quality Indicator	Measurement Performance Criteria
Method Blank	One per prep batch of 20 or fewer samples of similar matrix or one per day, whichever comes first	No analytes detected > MDC	Correct problem. If required, re-prepare and reanalyze MB and all samples processed with the contaminated blank.	Analyst/ Supervisor	Bias/Contamination	Same as Method/ SOP QC Acceptance Limits
Laboratory Control Sample		Recovery Limits: 75-125%	Identify problem; if not related to matrix interference, re-reanalyze LCS and all associated batch samples		Accuracy/Bias	
Laboratory Duplicate		RPD ≤25% and/or RER ≤1	Correct problem, then re-reanalyze all samples processed with the duplicate		Precision	
Carrier	Per sample, blank, LCS, MS, MSD	Strontium and Yttrium carriers: 40-110%	Truncate Carriers above 100% recovery to eliminate low biased results. Reprepare and reanalyze sample if carrier is low (indicating high biased results) if there is activity in the sample above the reporting limit. No reanalysis if matrix interference is nonconformance during sample preparation		Accuracy/Bias	

Notes:

DoD QSM v5.1 limits do not exist and the laboratory SOP limits will be used.

SAP Worksheet #28d—Laboratory QC Samples Soil Radon Emanation and Scintillation Counting

Matrix: Soil

Analytical Group: Radiological (Radon Emanation)

Analytical Method/SOP Reference: USEPA Method 903.1 mod/ GL-RAD-A-008

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for CA	Data Quality Indicator	Measurement Performance Criteria
Method Blank	One per prep batch of 20 or fewer samples of similar matrix or one per day, whichever comes first	No analytes detected > MDC	Correct problem. If required, re-prepare and reanalyze MB and all samples processed with the contaminated blank.	Analyst/ Supervisor	Bias/Contamination	Same as Method/ SOP QC Acceptance Limits
Laboratory Control Sample		Recovery Limits: 75-125%	Identify problem; if not related to matrix interference, re-reanalyze LCS and all associated batch samples		Accuracy/Bias	
Laboratory Duplicate		RPD ≤25% and/or RER ≤1	Correct problem, then re-reanalyze all samples processed with the duplicate		Precision	
Matrix Spike		Recovery Limits: 75-125%	Identify problem; if LCS recovery is acceptable, indicating possible matrix interference, no further CA necessary		Accuracy/Bias	

Notes:

DoD QSM v5.1 limits do not exist and the laboratory SOP limits will be used.

SAP Worksheet #29—Project Documents and Records

Document	Where Maintained
Final SAP, Work Plan, APP/SSHP, and Reports	Project file and NAVFAC Southwest Administrative Record
Field notes/logbooks	Project file
Field audits/reports	Project file
Chain-of-custody forms	Project file and analytical laboratory
Laboratory report: Laboratory raw data Corrective Action Report Laboratory equipment maintenance logs Sample preparation Run logs CLP-equivalent (Stage 4) analytical laboratory reports, including raw data	Analytical laboratory, project file, NAVFAC Southwest Administrative Record
Data validation reports	Data validator, project file, and NAVFAC Southwest Administrative Record Validated electronic data will be loaded into Naval Installation Restoration Information Solution (NIRIS), the Navy's centralized database

Notes:

Active project files will be maintained by the PM until project completion. Following project completion, hardcopy files will be archived at Iron Mountain. These files will be stored for a minimum of 10 years at the following location:

Iron Mountain Headquarters
745 Atlantic Avenue
Boston, Massachusetts 02111
(800) 899-IRON

Documents submitted to the NAVFAC Southwest Administrative Record are located at:

Commanding Officer
Naval Facilities Engineering Command, Southwest
1220 Pacific Highway (NBSD Bldg. 3519)
San Diego, CA 92132

Following response complete at the facility, hardcopy deliverables will be archived by the Navy at a Federal Records Center (FRC)
(http://www.archives.gov/frc/locations.html) where they are maintained for 50 years.

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SAP Worksheet #30—Analytical Services

Matrix	Analytical Group	Sample Locations/ ID Number	Analytical Method	Data Package Turnaround Time	Laboratory/Organization (name and address, contact person and telephone number)	Backup Laboratory/ Organization[a] (name and address, contact person and telephone number)
Soil	Gamma Spectroscopy	See **Worksheets #18** and **#20**	USEPA Method 901.1	28 calendar days for full deliverable	GEL Laboratories, LLC 2040 Savage Road Charleston, SC 29407 (843) 556-8171 POC: Valerie Davis	TBD
	Alpha Spectroscopy		USDOE Method HASL 300 A-01-R			
	GFPC		USEPA Method 905.0 mod			
	Radon Emanation		USEPA Method 903.1 mod			

Notes:

[a] A backup laboratory has not been identified. If circumstances render the subcontracted laboratory unable to perform the analytical services, another laboratory will be determined at that time.

Samples will be analyzed by laboratories that are accredited by the DoD Environmental Laboratory Accreditation Program (ELAP) (**Attachment 4**).

GEL Laboratories DoD ELAP Certification Number 2567.01 (A2LA), Valid to June 30, 2019. Status of laboratory certifications/accreditations will be verified prior to fieldwork and before samples are delivered to the laboratory. Updates to laboratory accreditation to ensure the laboratory is qualified to perform the analysis will be made prior to sample testing.

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SAP Worksheet #31—Planned Project Assessments

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment (title and organizational affiliation)	Person(s) Responsible for Responding to Assessment Findings (title and organizational affiliation)	Person(s) Responsible for Identifying and Implementing CA (title and organizational affiliation)	Person(s) Responsible for Monitoring Effectiveness of CA (title and organizational affiliation)
Operational Readiness Review (ORR)	Project startup	Internal	CH2M	Radiological STC CH2M	PM CH2M	PM CH2M	Radiological Lead CH2M
Field Sampling Technical Systems Audit (TSA)	At least one field TSA at the start of field activities	Internal	CH2M	Program Chemist (designee) CH2M	Field Team Leader CH2M	Field Team Leader CH2M	Radiological Lead CH2M
Data Review TSA	During field sampling and analysis through validation	Internal	CH2M	PM, Program Chemist CH2M	Field Team Leader (CH2M), Project Chemist, and Analytical Laboratory Manager	Project Chemist, Program Chemist (CH2M), and Analytical Laboratory Manager	Program Chemist CH2M
Quality Assurance/Quality Control	Project startup through completion of field investigation	Internal	CH2M	Quality Assessment Manager, CH2M Corporate Quality Assessment Manager, CH2M	PM, CH2M	PM, CH2M Quality Assessment Manager, CH2M	Quality Assessment Manager, CH2M

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SAP Worksheet #32—Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (name, title, organization)	Time Frame of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (name, title, organization)	Time Frame for Response
ORR	ORR Checklist	Kim Henderson PM CH2M	As soon as possible, within same day of finding	ORR Checklist with outstanding actions completed or addressed prior to project work.	Kim Henderson PM CH2M	1 business day
Field Sampling TSA	Audit form (See **Attachment 5**) showing results of field audit. If CAs are necessary and cannot be implemented during the audit, these deficiencies will be noted and their resolution will be documented in the CA Report.	TBD Field Team Leader CH2M	As soon as possible within same day of finding	Completed Audit Form indicating all CAs taken. Additional documentation will be attached as necessary. Audit form is issued by the STC.	Kevin Smallwood Field Team Leader CH2M	1 business day
		Kim Henderson PM CH2M	1 business day		Kim Henderson PM CH2M	1 business day
		Anita Dodson Program Chemist CH2M	1 business day		Anita Dodson Program Chemist CH2M	3 business days
		Danielle Janda/ George (Patrick) Brooks LRPM/BLTL Navy	1 business day if CA involving > 1 day delay is necessary		Danielle Janda/ George (Patrick) Brooks LRPM/BLTL Navy	Included with summary report
Data Review TSA	Memo or written audit report	Anita Dodson Program Chemist CH2M	1 business day	Letter or e-mail	Anita Dodson Program Chemist CH2M	3 business days

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SAP Worksheet #33—QA Management Reports

Type of Report	Frequency (daily, weekly, monthly, quarterly, annually)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (title and organizational affiliation)	Report Recipient(s) (title and organizational affiliation)
DQA • Provides an overview of sampling, decontamination, and data storage procedures • Identifies QC samples and summarizes associated analytical results • Summarizes the findings of the analytical data validation process • Provides an evaluation of data quality in accordance with the data quality indicator (DQIs) as defined in the SAP	Once for all data per parcel	Approximately 60 days after field investigation is complete	Program Chemist, CH2M STC, CH2M Project Chemist, CH2M	Navy LRPM/BLTL
Laboratory System Audit Reports	During DoD ELAP assessment or renewal of DoD ELAP certification	To be determined by DoD ELAP if offsite lab audit/ recertification is required	DoD ELAP Laboratory Evaluator	DoD ELAP POC (DoD ELAP) Laboratory Quality Assurance Managers
Field Sampling TSA Report	Once	Approximately 30 days after completion of audit	STC, CH2M	Navy LRPM/BLTL

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SAP Worksheet #34-36—Data Verification and Validation (Steps I and IIa/IIb) Process

Data Review Input	Description	Responsible for Verification or Validation[a]	Step I/ IIa/IIb[a]	Internal/External[b]
Field Notebooks	Field notebooks will be reviewed internally and placed into the project file for archival at project closeout.	Field Team Leader/CH2M	Step I	Internal
Chains-of-Custody and Shipping Forms	Chain-of-custody forms and shipping documentation will be reviewed internally upon their completion and verified against the packed sample coolers they represent. The shipper's signature on the chain-of-custody will be initialed by the reviewer, a copy of the chains-of-custody retained in the site file, and the original and remaining copies taped inside the cooler for shipment. Chains-of-custody will also be reviewed for adherence to the SAP by the project chemist.	Field Team Leader/CH2M Project Chemist/CH2M	Step I	Internal & External
Sample Condition upon Receipt	Any discrepancies, missing, or broken containers will be communicated to the project chemist in the form of laboratory logins.	Project Chemist/CH2M	Step I	External
Documentation of Laboratory Method Deviations	Laboratory Method Deviations will be discussed and approved by the project chemist. Documentation will be incorporated into the case narrative which becomes part of the final hardcopy data package.	Project Chemist/CH2M	Step I	External
Electronic Data Deliverables	Electronic Data Deliverables (EDDs) will be compared against hardcopy laboratory results (10 percent check). Discrepancies will be resolved with the laboratory.	Project Chemist/CH2M	Step I	External
Case Narrative	Case narratives will be reviewed by the data validator during the data validation process. This is verification that they were generated and applicable to the data packages.	Data Validator/CH2M	Step I	External
Laboratory Data	All laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal.	Respective Laboratory QAO	Step I	Internal
Laboratory Data	The data will be verified for completeness by the project chemist. In order to ensure completeness, EDDs will be compared to the SAP. This is a verification that all samples were included in the laboratory data and that correct analyte lists were reported.	Project Chemist/CH2M	Step I	External
Audit Reports	Upon report completion, a copy of all audit reports will be placed in the site file. If CAs are required, a copy of the documented CA taken will be attached to the appropriate audit report in the QA site file. Periodically, and at the completion of site work, site file audit reports and CA forms will be reviewed internally to ensure that all appropriate CAs have been taken and that CA reports are attached. If CAs have not been taken,	PM/CH2M Project Chemist/CH2M	Step I	Internal

	the site manager will be notified to ensure action is taken.			
Corrective Action Reports	Corrective action reports will be reviewed by the project chemist or PM and placed into the project file for archival at project closeout.	PM/CH2M Project Chemist/CH2M	Step I	External
Laboratory Methods	During the pre-validation check, ensure that the laboratory analyzed samples using the correct methods specified in the UFP-SAP. If methods other than those specified in the SAP were used, the reason will be determined and documented.	Project Chemist/CH2M	Step IIa	External
Target Compound List and Target Analyte List	During the pre-validation check, ensure that the laboratory reported all analytes from each analysis group in accordance with **Worksheet #15**. If the target compound list is not correct, then it must be corrected prior to sending the data for validation. Once the checks are complete, the PM is notified via e-mail.	Project Chemist/CH2M	Step IIa	External
Reporting Limits	Ensure the laboratory met the project-designated QLs shown in **Worksheet #15**. If QLs were not met, the reason will be determined and documented.	Project Chemist/CH2M	Step IIb	External
Field SOPs	Ensure that all field SOPs were followed.	Field Team Leader/CH2M	Step I	Internal
Laboratory SOPs	Ensure that approved analytical laboratory SOPs were followed.	Respective Laboratory QAO	Step I	Internal

SAP Worksheet #34-36—Data Verification and Validation (Steps I and IIa/IIb) Process (continued)

Data Review Input	Description	Responsible for Verification or Validation[a]	Step I/ IIa/IIb[a]	Internal/External[b]
Laboratory Data	A compliance check will be performed to compare the documented receipt conditions and analytical QC results in the data package to acceptance criteria this SAP and validation guidelines referenced in **Worksheet #14**.	Data Validator/TBD	Step IIa	External
Raw Data	20 percent review of instrument outputs and recalculation checks of raw data to confirm identifications and laboratory calculations. For a recalculated result, the data validator attempts to re-create the reported numerical value. The laboratory is asked for clarification if a discrepancy is identified which cannot reasonably be attributed to rounding. In general, this is outside 5 percent difference.	Data Validator/TBD	Step IIa	External
Onsite Screening	All non-analytical field data will be reviewed against SAP requirements for completeness and accuracy based on the field calibration records.	Field Team Leader/CH2M	Step IIb	Internal
Documentation of Method QC Results	Establish that all required QC samples were run and met limits.	Data Validator/TBD	Step IIa	External
Documentation of Field QC Sample Results	Establish that all required QC samples were run and met limits.	Project Chemist/CH2M	Step IIa	Internal
DoD ELAP Evaluation	Ensure that each laboratory is DoD ELAP Certified for the analyses they are to perform. Ensure evaluation timeframe does not expire.	Project Chemist/CH2M	Step I	External
Analytical data for radiological parameters in all samples.	Analytical methods and laboratory SOPs as presented in this SAP will be used to evaluate compliance against QA/QC criteria. Should adherence to QA/QC criteria yield deficiencies, data may be qualified. Data may be qualified if QA/QC exceedances have occurred and is summarized in Table 34_36-1. Guidance and qualifiers from MARLAP (USEPA et al., 2004), MARSSIM (USEPA et al., 2000), and USEPA National Functional Guidelines for Inorganic Superfund Data Review (ISM02.2) (USEPA, 2017) may also be applicable. Of the analytical data, 100 percent will be validated by a third-party data validation subcontractor, with 20 percent of the sample delivery groups subject to Stage 4 validation and 80 percent subject to Stage 2B validation. Stage 4 data validation follows the USEPA protocols and criteria set forth in the functional guidelines for inorganic and radiological data review (USEPA et al., 2000, 2004; USEPA, 2017). These guidelines apply to analytical data packages that include the raw data (e.g., spectra and	Data Validator/TBD	Step IIa and IIb	External

	chromatograms) and backup documentation for calibration standards, analysis run logs, laboratory control samples (LCSs), dilution factors, and other types of information. This additional information is used in the Stage 4 data validation process for checking calculations of quantified analytical data. Calculations are checked for QC samples (e.g., matrix spike [MS]/matrix spike duplicate [MSD] and LCS data) and routine field samples (including field duplicates, field and equipment rinsate blanks). To ensure that detection limit and data values are appropriate, an evaluation is made of instrument performance, method of calibration, and the original data for calibration standards. Under the Stage 2B data validation effort, the data values for primary and QC samples are generally assumed to be correctly reported by the laboratory. Data quality is assessed by comparing the QC parameters listed in the previous paragraph to the appropriate criteria (or limits) as specified in this SAP, by DoD-QSM v5.1 requirements, or by method-specific requirements (e.g., EPA, DOE). If calculations for quantitation are verified, it is done on a limited basis and may require raw data in addition to the standard data forms normally present in a data package.			

Notes:

[a] Verification (Step I) is a completeness check that is performed before the data review process continues in order to determine whether the required information (complete data package) is available for further review. Validation (Step IIa) is a review that the data generated is in compliance with analytical methods, procedures, and contracts. Validation (Step IIb) is a comparison of generated data against measurement performance criteria in the SAP (both sampling and analytical). Should CH2M find discrepancies during the verification or validation procedures above, an e-mail documenting the issue will be circulated to the internal project team, and a Corrections to File Memo will be prepared identifying the issues and the CA. This Memo will be sent to the laboratory, or applicable party, and maintained in the project file.

[b] Internal or external is in relation to the data generator.

SAP Worksheet #34-36—Data Verification and Validation (Steps I and IIa/IIb) Process (continued)

Table 34_36-1. Data Validation Guidance for Data Qualification

Quality Control Check	Evaluation	Data Qualification	Samples Affected
Holding Time	Holding time exceeded for extraction, digestion, or analysis	J = positive results; Nondetects = use professional judgment – UJ or R	All analytes in sample
Sample Preservation	N/A	None required	
Temperature	N/A	None required	
ICAL (See **Worksheet #24** for criteria)			
Energy	Energy difference outside criteria	Sample > MDC; qualify as estimated (J) Sample < MDC; qualify as estimated (UJ)	Associated analytes in all samples in analytical batch
Efficiency	Efficiency difference outside criteria	Sample > MDC; qualify as estimated (J) Sample < MDC; qualify as estimated (UJ)	
FWHM peak resolution	FWHM peak resolution outside criteria	Sample > MDC; qualify as estimated (J) Sample < MDC; qualify as estimated (UJ)	
ICV	Observed peaks in ICV greater than 10% of ICAL value	Sample > MDC; qualify as estimated (J) Sample < MDC; qualify as estimated (UJ)	Associated analytes in all samples in analytical batch
CCV (Daily Check)	Energy, efficiency, or FWHM outside criteria	Sample > MDC; qualify as estimated (J) Sample < MDC; qualify as estimated (UJ)	Associated analytes in all samples in analytical batch
BSC	Background count rate of entire spectrum > 3σ of the average	Sample > MDC; qualify as estimated (J) Sample < MDC; qualify as estimated (UJ)	All associated samples in analytical batch
ICC	Background count rate of entire spectrum > 3σ of the average	Sample > MDC; qualify as estimated (J) Sample < MDC; qualify as estimated (UJ)	All associated samples in analytical batch
LCS	%R >UCL	Sample > MDC; qualify as estimated (J) Sample < MDC; None required	Associated analytes in all samples in preparation batch or analytical batch

	%R <LCL but ≥ 30%	Sample > MDC; qualify as estimated (J) Sample < MDC; qualify as estimated (UJ)	
	%R <30%	Sample > MDC; qualify as estimated (J) Sample < MDC; qualify as unusable (R)	
Method Blank	Blank < MDC	None required	Associated analytes in all samples in preparation batch or analytical batch
	Blank > MDC	Sample < MDC; None required Sample > MDC by < 10x blank; qualify as estimated (J) Sample > 10x blank; None required	
Tracer Recovery (alpha spectroscopy only) Carrier Recovery (GFPC ony)	%R >UCL	Sample > MDC; qualify as estimated (J) Sample < MDC; None required	Associated analytes in affected samples
	%R <LCL but ≥ 10%	Sample > MDC; qualify as estimated (J) Sample < MDC; qualify as estimated (UJ)	
	%R <10%	Sample > MDC; qualify as estimated (J) Sample < MDC; qualify as unusable (R)	

SAP Worksheet #34-36—Data Verification and Validation (Steps I and IIa/IIb) Process (continued)

Table 34_36-1. Data Validation Guidance for Data Qualification

Quality Control Check	Evaluation	Data Qualification	Samples Affected
Laboratory Control Sample Duplicates	Concentration of reported analytes are > 5x the MDC in either sample and RPD ≥ 25% and/or RER ≥ 1	Sample > MDC; qualify as estimated (J) Sample < MDC; qualify as estimated (UJ)	Analytes in parent sample
	Concentration of reported analytes are < 5x the MDC in either sample and absolute difference > 3x MDC	Sample > MDC; qualify as estimated (J) Sample < MDC; qualify as estimated (UJ)	
Matrix Spike[1]	%R >UCL	Sample > MDC; qualify as estimated (J) Sample < MDC; None required	Associated analytes in all samples in preparation batch or analytical batch
	%R <LCL but ≥ 30%	Sample > MDC; qualify as estimated (J) Sample < MDC; qualify as estimated (UJ)	
	%R <30%	Sample > MDC; qualify as estimated (J) Sample < MDC; qualify as unusable (R)	
Field Duplicates	Concentration of reported analytes are > 5x the MDC in either sample and RPD ≥ 25% and/or RER ≥ 1	Sample > MDC; qualify as estimated (J) Sample < MDC; qualify as estimated (UJ)	Analytes in parent sample and field duplicate
	Concentration of reported analytes are < 5x the MDC in either sample and absolute difference > 3x MDC	Sample > MDC; qualify as estimated (J) Sample < MDC; qualify as estimated (UJ)	

Notes:

< = less than
> = greater than

All QA/QC criteria are included in **Worksheets #12, #24**, and **#28** and will be used for validation criteria.
[1]If activity of the sample > 5 times the spiking level.
%R = percent recovery
LCL = lower control limit
UCL = upper control limit

SAP Worksheet #37—Usability Assessment

The DQO for the project include the following goals:

- To evaluate and document the validity of the obtained radiological data to support decisions
- To corroborate prior survey results if necessary
- To compare radiological data to RGs.
- To recommend additional remediation if necessary
- To compare radiological data to applicable natural background values.

Assessment of sampling and survey data consists of four separate and identifiable phases: data reduction, data verification, data validation, and DQA. These processes will be performed in accordance with MARLAP (USEPA et. Al, 2004) and other applicable guidance. Data reduction involves data transformation processes such as converting raw data into reportable quantities and units, using significant figures, and calculating measurement uncertainties. Verification and validation pertain to evaluation of survey and analytical data and are considered as two separate processes.

Data verification compares the survey and sampling data collection against the requirements of the project-specific Work Plan and SOPs. For example, the actual survey locations, scan speed, number and location of systematic static survey measurements, and the number and location of swipe samples will be compared with the planned survey activities. A verification report may be prepared depending on the size and complexity of the survey. The verification report identifies those requirements that were not met (called exceptions). Task-specific verification checklists will be developed in accordance with MARLAP Section 8.5 prior to field mobilization to ensure that requirements identified in the work planning documents are met. Data verification also involves reviewing data that was transcribed or transferred into the electronic data management systems. The data verification will be performed by the radiological STC and other senior staff with access to the original data, SOPs, and the Parcel G Work Plan.

At HPNS, the verification process will include the following:

- Appropriate selection of the survey instruments
- Appropriate survey methods for the ROCs
- Evaluation of data completeness
- Verification of instrument/detector calibration
- Daily response checks of the instrument/detector
- Assessment of survey method specifications, including scan speed, distance from the detector to surveyed surface, survey path, time that counts are collected, and adherence to operator response requirements, such as response to measurements exceeding the investigation level and documentation of adverse conditions
- Retrospective calculation of MDCs
- Adjustments of background count rate settings
- Checks on instrument system performance
- Swipes collected as required: labeling, analyses, and documentation
- Recorded measurement and sample locations per project requirements

SAP Worksheet #37—Usability Assessment (continued)

Validation is a systematic check on the set of survey or analytical data being used to meet the project requirements and is performed to addresses the usability of the data. The validation process begins with a review of the survey or analytical data package to identify its areas of strength and weakness. The validation process should determine the impact of not meeting the requirements of the Parcel G Work Plan and SOPs. Validation then evaluates the data to determine the absence of a required survey measurement and the uncertainty of the survey process. During validation, the technical reliability and the degree of confidence in the reported survey data are considered. The validator will note if data that do not meet the performance criteria (**Worksheet #28**). The products of the validation process are validated data and a statement on which data are acceptable and which data are sufficiently inconsistent that it should not be used in the decisions for which the survey data was collected.

The DQA is the last phase of the data collection process and consists of a scientific and statistical evaluation of project-wide knowledge to assess data usability. DQA considers all sampling, analytical, and data handling details, external QA assessments, and other historical project data to determine the usability of data for decision-making. To assess and document overall data quality and usability, the data quality assessor integrates the data validation report, field information, assessment reports, and historical project data, and compares the findings to the DQOs objectives defined in the Parcel G Work Plan and this SAP. The DQA process uses the combined findings of these multi-disciplinary assessments to determine data usability for the intended decisions, and to generate a DQA report documenting that usability and the causes of any deficiencies.

The DQA process varies depending on the survey objectives, and the level and depth of the verification. The process will evaluate and document the usability of the data by considering the project DQIs, which are precision, accuracy, representativeness, completeness, comparability, and sensitivity (PARCCS). The DQA process will determine whether the data will be suitable for the intended needs of the project. Every data type (e.g., sampling, field screening data, and laboratory analytical data) will be relevant to the usability assessment. Data usability will include the entry of analytical data validation flags, applied by the third-party analytical data validation subcontractor, to the project data, as well as an overall assessment of the analytical data and field QC samples.

The assessment will consider the relationship of each type of data to the entire data set, and the adequacy of the data to fulfill the project DQOs. The data will be assessed for correctness, completeness, and compliance to method- or project-specific QA/QC requirements, including the results of the independent analytical data validation process and contractual requirements. Analytical data validation will evaluate the data based on the PARCCS criteria defined in this SAP and other method-specific performance requirements. The overall assessment process will also evaluate data usability based on the intended use of the data. The intent of the DQA process will be to establish the PARCCS levels and usability of the final results with respect to the project DQOs. Upon completion of analytical data validation, each data point will be assessed as non-qualified, qualified as estimated ("J" or "UJ" qualified), or qualified as rejected ("R" qualified) based upon the acceptance criteria, and analytical data validation flags will be added to the project data. These parameters will be based on the analytical data quality and will encompass the DQIs established in this SAP. Qualification will be given according to each sample's delivery group and will be based on the SAP and applicable laboratory and data validation SOPs. Both analytical and contractual compliance and completeness levels will be assessed for each analytical parameter. Finally, the overall usefulness of the data will be established as related to the project DQOs.

Data Quality Indicators

Quantifiable criteria, known as measurement performance criteria, are presented in **Worksheet #12**. The PARCCS criteria will be the qualitative and quantitative indicators of data quality. The PARCCS criteria are defined and discussed as follows.

SAP Worksheet #37—Usability Assessment (continued)

Precision

Precision is a measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision will be measured by using laboratory duplicates and field duplicate samples. It will be expressed in terms of the RPD as follows:

$$RPD = \frac{|C_1 - C_2|}{(C_1 + C_2)/2} \times 100$$

where:

RPD = relative percent difference
C_1 = concentration of sample or MS
C_2 = concentration of duplicate or MSD

For the evaluation of precision between the native sample and its associated field duplicate, the sample results must be greater than 5 times the MDC in order for the RPD criteria (See **Worksheet #12**) to apply. When either the sample or field duplicate results are less than 5 times the MDC, then the RER must be less than 1 using the following equation:

$$RER = \frac{|S - D|}{2\sigma s + 2\sigma d}$$

where:

RER = relative error ratio
S = concentration of sample
D = concentration of duplicate
σs = uncertainty of sample result
σd = uncertainty of duplicate result

If either the RPD or RER fail the criteria, the native sample and field duplicate results will be qualified as estimated ("J" flag). Other site-specific field duplicate and laboratory duplicate results will be evaluated for trends and if the exceedance is due to the sample matrix or field sample collection, as well as if resampling is warranted. This evaluation and any impact related to ROCs will provided in the DQA.

Accuracy

Accuracy is the degree of agreement of an observed measurement (or an average of the same measurement type) with an accepted reference or true value. Accuracy of analytical determinations will be measured using laboratory QC analyses such as LCSs and surrogate spikes. Accuracy will be measured by evaluating the actual result against the known concentration added to a spiked sample and will be expressed as %R as shown below:

$$\%R = \frac{S - U}{C_{sa}} \times 100$$

where:

%R = Percent Recovery

S = Measured concentration of spiked aliquot
U = Measured concentration of unspiked aliquot
C_{sa} = Concentration of spike added

SAP Worksheet #37—Usability Assessment (continued)

Representativeness

Representativeness is the reliability with which a measurement or measurement system reflects the true conditions under investigation. Representativeness is influenced by the number and location of the sampling points, sampling timing and frequency of monitoring efforts, and the field and laboratory procedures. The representativeness of data will be maintained by the use of established field and laboratory procedures and their consistent application.

Comparability

Comparability expresses the confidence with which one data set can be compared to another based on using USEPA-defined procedures, where available. If USEPA procedures are not available, the procedures have been defined or referenced in this SAP.

The comparability of data will be established through well documented methods and procedures, standard reference materials, QC samples, performance-evaluation study results, and by reporting each data in consistent units.

Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct normal conditions. Analytical data validation and DQA will determine which data will be valid and which data will be rejected. Percent completeness will be defined as follows:

$$Percent\ Completeness = \frac{V}{T} \times 100$$

where:

- V = Number of valid (not rejected) measurements over a given time
- T = Total number of planned measurements

The completeness goal for this project will be 90 percent for valid, usable data. If the completeness goal of the project is not achieved, a discussion on the limitations on the use of the project data will be included in the Usability Assessment section of the DQA.

Sensitivity

Sensitivity is the measure of a concentration at which an analytical method can positively identify and report analytical results. The sensitivity of an analytical method will be indicated by the project-required reporting limits, as compared to the RGs.

Detection and Quantitation Limits

The MDC is an estimate of the smallest true activity (or activity concentration) of an analyte in a sample that ensures a 95 percent probability of detection, give a detection criterion that ensures on a 5 percent probability of detection in an analyte-free sample. The MDCs are contractually specified minimum detection limits for specific analytical methods and sample matrices.

For this project, concentrations below the MDC will be reported as “U” to the MDC.

SAP Worksheet #37—Usability Assessment (continued)

Describe the evaluative procedures used to assess overall measurement error associated with the project:

The usability assessment process will consist of reviewing the analytical data validation reports for usable analytical data (i.e., no validation qualifications or estimated "J"/"UJ" qualifications) and rejected ("R" qualified) analytical data, as well as evaluating the field and analytical data for discrepancies or deviations. This assessment will evaluate the impact of the discrepancies or deviations on the usability of the data and assesses whether the necessary information has been provided for use in the decision-making process. The assessment will evaluate whether there were deviations in sampling activities (e.g., incorrect sample location, improper or malfunctioning sampling equipment, or incorrect analysis performed), chain-of-custody documentation, or holding times; compromised samples (i.e., damaged or lost samples) and the need to resample; or changes to SOPs or methods that could potentially affect data quality.

An evaluation of QC sample results will be performed to assess whether unacceptable QC results (e.g., blank contamination) affect data usability.

Other parameters to be evaluated during the usability assessment may include, but will not be limited to, the following:

- Matrix effects—matrix conditions that might have affected the performance of the extraction or analytical method
- Site conditions—unusual weather conditions or site conditions that might have affected the sampling plan
- Identifying critical and noncritical samples or target analytes
- Background or historical data
- Data restrictions—data that do not meet the project DQOs or were "R" qualified might be restricted, but usable, as qualitative values for limited decision-making purposes

Identify the personnel responsible for performing the usability assessment:

Project Chemist, CH2M, Mark Cichy

Data Validation Subcontractor, TBD

The project team will be consulted as appropriate to determine final usability of the collected data.

Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented, so that they identify trends, relationships (correlations), and anomalies:

DQA/Data Usability Assessment will be reported in the Confirmation Survey Report.

The data will be evaluated for overall PARCCS criteria for each matrix, analytical group, and concentration level, and data use limitations will be discussed in the DQA/Data Usability Assessment Reports for data that do not meet the project DQOs or DQIs. The DQA/Data Usability Assessment reports will include a detailed discussion of the data usability evaluations with sufficient information to support the data usability conclusions, such as the following:

- a detailed description of the regulatory requirements and technical bases for assessment
- review of data reduction, verification and validation

SAP Worksheet #37—Usability Assessment (continued)

- assessment of trends and biasesequilibrium of radionuclide decay chains
- analysis of environmental radioactivity
- variations of natural radionuclides
  - satisfaction of quality objectives
  - overall defensibility and usability
  - appropriate analysis to support usability.

The level of data verification, validation, and DQA performed on radiological samples is defined in **Worksheet #34-36**. Copies of surveys, sampling, and analytical data (and their supporting data) will be protected and maintained in project record files.

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Figures

Attachment 1
Project Scoping Meeting Minutes

Attachment 2
Field SOPs

Attachment 3
Laboratory SOPs

Attachment 4
Laboratory Certifications

Attachment 5
Technical Systems Audit Checklist

Naval Facilities Engineering Command Southwest
BRAC PMO West
San Diego, CA

Final

Parcel G Removal Site Evaluation Work Plan

Former Hunters Point Naval Shipyard
San Francisco, California

January 2019

Naval Facilities Engineering Command Southwest
BRAC PMO West
San Diego, CA

Final

Parcel G Removal Site Evaluation Work Plan

Former Hunters Point Naval Shipyard
San Francisco, California

January 2019

Signature Quality Assurance Manager	Date
Signature Radiation Safety Officer	Date
Signature Project Manager	Date

Executive Summary

Background

Radiological surveys and remediation were previously conducted at former Hunters Point Naval Shipyard (HPNS) as part of a basewide Time-critical Removal Action (TCRA). Tetra Tech EC, Inc. (TtEC), under contracts with the Department of the Navy (Navy), conducted a large portion of the basewide TCRA, including Parcel G. Data manipulation and falsification were committed by TtEC employees during the TCRA. An independent third-party evaluation of previous data identified additional potential manipulation, falsification, and data quality issues with data collected at Parcel G (Navy, 2017, 2018). As a result, the Navy developed this work plan to investigate radiological sites in Parcel G. Future work plans will address soil and buildings in the other parcels (B, C, D-2, E, UC-1, UC-2, and UC-3), including the North Pier and Ship Berths.

Project Purpose

The purpose of the investigation presented in this work plan is to determine whether current site conditions are compliant with the remedial action objective (RAO) in the Parcel G Record of Decision (ROD) (Navy, 2009). The RAO for radiologically impacted soil and structures is to prevent receptor exposure to radionuclides of concern (ROCs) in concentrations that exceed remediation goals (RGs) for all potentially complete exposure pathways. Additional reference background areas (RBAs) will also be identified to confirm, or update as necessary, estimates of naturally occurring and man-made background levels for ROCs not attributed to Naval operations at HPNS. A statistical comparison of site data to applicable reference area data will be conducted.

Scope

The radiological investigation will be conducted at the following sites:

- Former Sanitary Sewer and Storm Drain Trenches
- Former Buildings 317/364/365 Site
- Building 351A
- Building 351
- Building 366
- Building 401
- Former Building 408 Concrete Pad
- Building 411
- Building 439

The sites and the locations of work are shown on **Table ES-1** and **Figure ES-1**.

Soil Investigations

Soil investigations will be conducted at the following areas:

- Former Sanitary Sewer and Storm Drain Trenches
- Former Buildings 317/364/365 Site
- Building 351A Crawl Space

Soil investigation areas will be divided into trench units (TUs) and surface soil survey units (SUs). The size and boundary of the TUs and SUs will be based on the previous plans and reports.

Former Sanitary Sewer and Storm Drain Trench Units

For the TUs associated with former sanitary sewers and storm drains (from 1 to 22 feet deep), a phased investigation approach was designed based on a proposal by the regulatory agencies to achieve a high level of confidence that the Parcel G ROD RAO has been met for soil (Attachment 2.1 in **Appendix A**). For Phase 1, 100 percent of soil will be re-excavated and characterized at 33 percent of TUs in Parcel G. Soil sampling and scanning at the remaining 67 percent of TUs will be performed as part of Phase 2 to increase confidence that current site conditions comply with the Parcel G ROD RAO. The Navy will re-excavate 100 percent of Phase 2 TUs if contamination is identified in Phase 1 TUs. For both Phase 1 TUs and Phase 2 TUs, the durable cover (including asphalt, asphalt base course, concrete, gravel, debris, or obstacles) will be removed to expose the target soils.

Phase 1

Phase 1 includes the radiological investigation on a targeted group of TUs. Twenty-one of the 63 former sanitary sewer and storm drain TUs were selected for the Phase 1 investigation.

The radiological investigation of soil includes the following:

- Collection of systematic soil samples from each TU
- Gamma scan of 100 percent of the soil
- Collection of biased soil samples, where necessary, based on the gamma scan measurements

The targeted TUs were selected based on the highest potential for radiological contamination. The following information was used to select the units:

- Historical documentation of specific potential upstream sources, spills, or other indicators of potential contamination (NAVSEA, 2004)
- Signs of potential manipulation or falsification from the soil data evaluation (Navy, 2017, 2018)

All of the soil (100 percent) will be excavated to the original TU boundaries, as practicable, and gamma scans of the excavated material will be conducted. Excavated soil will be gamma scanned by one of two methods. Soil may be laid out on Radiological Screening Yard pads for a surface scan, or soil may be processed and scanned using soil segregation technology. Following excavation to the original TU boundaries, additional excavation of approximately 6 inches of the trench sidewalls and floors will be performed to provide ex situ scanning and sampling of the trench sidewalls and floors. The excavated soil from within each trench and the over-excavation will be tracked separately, and global positioning system (GPS) location-correlated results will be collected.

Systematic and biased samples will be collected from the excavated soil from the TUs and from the soil surrounding the TUs. A minimum of 18 systematic samples will be collected from each excavated soil unit and TU. The soil samples will be analyzed for the applicable ROCs by accredited offsite laboratories. Soil sample locations will be surveyed using GPS. If the investigation results from the gamma scan surveys and results from analysis of systematic and biased soil samples of the over-excavated material demonstrate exceedances of the RGs that are not attributed to naturally occurring radioactive material (NORM) or anthropogenic background, the material will be segregated for further evaluation. An in situ investigation and/or remediation of the trench sidewalls and floor will be performed prior to backfill.

Phase 2

At the remaining 42 TUs, 100 percent radiological surface gamma scan of accessible areas and soil sampling will be conducted. Subsurface soil samples will be collected via borings, with a minimum of 18 borings within the trench and 1 boring every 50 linear feet along the sidewalls of the trench. The borings will be advanced beyond the floor boundary of the trench or to the point of refusal. Gamma scans of the core will be conducted. Borehole locations will be surveyed using GPS. The soil samples will be analyzed for the applicable ROC analysis by accredited offsite laboratories.

Former Building Site and Crawl Space Soil Survey Units

At the 28 surface soil SUs[1] from the Former Buildings 317/364/365 Site and Building 351A Crawl Space, the radiological investigation of soil is based on a proposal by the regulatory agencies (Attachment 2.1 in **Appendix A**) and includes the following:

- Collection of a minimum of 18 systematic soil samples from each SU
- Gamma scan of 100 percent of the soil
- Collection of biased soil samples, where necessary, based on the gamma scan measurements

For all the surface soil SUs, a surface gamma scan of 100 percent of surface soil will be conducted as walk-over or drive-over surveys. GPS location-correlated results will be collected. Systematic and biased samples will be collected from the surface soil SUs. The soil samples will be analyzed for the applicable ROCs by accredited offsite laboratories. Soil sample locations will be surveyed using GPS.

Building Investigations

Investigations of interior surfaces will be performed for the following buildings:

- Building 351A
- Building 351
- Building 366
- Building 401
- Former Building 408 Concrete Pad
- Building 411
- Building 439

Buildings will be divided into SUs, and the size and boundary of the SUs will be based on the previous plans and reports. The radiological investigation will be conducted to include the following:

- Collection of a minimum of 18 systematic static alpha-beta measurements from each SU
- Alpha and beta scan of surfaces
- Collection of biased static alpha-beta measurement where necessary, based on the alpha-beta scan measurements
- Collection of swipe samples

Data Evaluation and Reporting

Data from the radiological investigation will be evaluated to determine whether the site conditions are compliant with the Parcel G ROD RAO. If the residual ROC concentrations are below the RGs in the Parcel G ROD or are shown to be NORM or anthropogenic background, then the site conditions are compliant with the Parcel G ROD RAO. **Section 5** of this work plan provides additional information and details on data evaluation and reporting.

The following methods will be used to determine whether the residual ROC concentrations comply with the Parcel G ROD RAO:

[1] Previously, 32 SUs were investigated at the Former Buildings 317/364/365 Site and Building 351A Crawl Space; however, some SU areas overlapped. For the Former Buildings 317/364/365 Site, former SU 22 overlaps TU 153 and will be investigated as part of TU 153. For the Building 351A Crawl Space, former SU R, SU S, and SU U overlap SU M, SU N, and SU O and will be investigated as SU M, SU N, and SU O.

- Each sample and static measurement result will be compared to the corresponding RG. If all residual ROC concentrations are less than or equal to the corresponding RG, then site conditions comply with the Parcel G ROD RAO.
- Sample and measurement data will be compared to appropriate RBA data, and multiple lines of evidence will be evaluated to determine whether site conditions are consistent with NORM or anthropogenic background. The data evaluation may include, but is not limited to, population-to-population comparisons, use of a maximum likelihood estimate (MLE) or background threshold value, graphical comparisons, and comparison with regional background levels. If all residual ROC concentrations are determined to be consistent with NORM or anthropogenic background, then site conditions comply with the Parcel G ROD RAO.
- Each radium-226 (^{226}Ra) sample result exceeding both the corresponding RG and the expected range of background will be compared to concentrations of other radionuclides in the uranium natural decay series (see **Section 5.6**). If the concentrations of radionuclides in the uranium natural decay series are consistent with the assumption of secular equilibrium, then the ^{226}Ra concentration is NORM, and site conditions comply with the Parcel G ROD RAO.

If the investigation results demonstrate that there are no exceedances determined from a point-by-point comparison with the statistically-based RGs[2] at agreed upon statistical confidence levels, or that residual ROC concentrations are NORM or anthropogenic background, then a remedial action completion report (RACR) will be developed.

If the investigation results demonstrate exceedances of the RGs determined from a point-by-point comparison with the statistically-based RGs[2] at agreed upon statistical confidence levels and are not shown to be NORM or anthropogenic background, then remediation will be conducted, followed by a RACR.

The RACR will describe the results of the investigation, explain remediation performed, compare the distribution of data from the sites with applicable reference area data, and provide a demonstration that site conditions are compliant with the Parcel G ROD RAO through the use of multiple lines of evidence including application of statistical testing with agreed upon statistical confidence levels on the background data.

[2] The RGs are statistically based because they are increments above a statistical background.

Contents

Appendixes

Tables

Figures

Acronyms and Abbreviations

^{60}Co	cobalt-60
^{90}Sr	strontium-90
^{90}Y	ytrium-90
^{99}Tc	technetium-99
^{137}Cs	cesium-137
^{214}Bi	bismuth-214
^{222}Rn	radon-222
^{220}Rn	thoron-220
^{226}Ra	radium-226
^{230}Th	thorium-230
^{232}Th	thorium-232
^{234}U	uranium-234
^{235}U	uranium-235
^{238}U	uranium-238
^{239}Pu	plutonium-239
µCi/mL	microcurie(s) per milliliter
AHA	activity hazard analysis
ALARA	as low as reasonably achievable
ANSI	American National Standards Institute
APP	accident prevention plan
ASTM	ASTM International (formerly American Society for Testing and Materials)
bgs	below ground surface
BMP	best management practice
BRAC	Base Realignment and Closure
BTV	background threshold value
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CH2M	CH2M HILL, Inc.
cm	centimeter(s)
cm^2	square centimeter(s)
cm/s	centimeter(s) per second
cpm	count(s) per minute
cpm/µR/hr	count(s) per minute per microroentgen per hour
CSM	conceptual site model
DAC	derived air concentration

dBA	decibels
dpm	disintegration(s) per minute
dpm/100 cm^2	disintegration(s) per minute per 100 square centimeters
DOT	Department of Transportation
DQA	data quality assessment
DQO	data quality objective
ESU	excavation soil unit
GPS	global positioning system
HAZWOPER	Hazardous Waste Operations and Emergency Response
HPNS	Hunters Point Naval Shipyard
HRA	Historical Radiological Assessment
ID	identification
IL	investigation level
keV	kiloelectron volt
LBGR	lower boundary of the gray region
LLRW	low-level radioactive waste
LWTS	liquid waste transfer system
m^2	square meter(s)
m^3	cubic meter(s)
m/s	meter(s) per second
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	minimum detectable concentration
MDCR	minimum detectable count rate
MLE	maximum likelihood estimate
MOU	memorandum of understanding
NA	not applicable
NaI	sodium iodide
NaI(Tl)	sodium iodide activated with thallium
Navy	Department of the Navy
NORM	naturally occurring radioactive material
NRC	Nuclear Regulatory Commission
NRDL	Navy Radiological Defense Laboratory
NUREG	Nuclear Regulatory Commission Regulation
OSHA	Occupational Safety and Health Administration
pCi/g	picocurie(s) per gram
Perma-Fix	Perma-Fix Environmental Services
PPE	personal protective equipment

PRSO	Project Radiation Safety Officer
PSPC	position-sensitive proportional counter
Q-Q	quantile-quantile
QA	quality assurance
QC	quality control
RACR	remedial action completion report
rad	radiation absorbed dose
RAO	remedial action objective
RASO	Radiological Affairs Support Office
RBA	reference background area
RCA	radiologically controlled area
RCRA	Resource Conservation and Recovery Act
RCT	Radiological Control Technician
rem	roentgen(s) equivalent man
RG	remediation goal
ROI	region of interest
ROICC	Resident Officer in Charge of Construction
ROC	radionuclide of concern
ROD	record of decision
RPM	Remedial Project Manager
RSCS	Radiation Safety and Control Services, Inc.
RSO	Radiation Safety Officer
RSY	Radiological Screening Yard
RWP	Radiation Work Permit
SAP	sampling and analysis plan
SCM	surface contamination monitor
SFU	sidewall floor unit
SIMS	Survey Information Management System
SOP	standard operating procedure
SSHO	Site Safety and Health Officer
SSHP	site safety and health plan
SU	survey unit
SWPPP	stormwater pollution prevention plan
TCRA	time-critical removal action
TtEC	Tetra Tech EC, Inc.
TU	trench unit
UBGR	upper boundary of the gray region

USEPA	United States Environmental Protection Agency
VD	virtual detector
VOC	volatile organic compound
VSP	Visual Sample Plan

SECTION 1

Introduction

This work plan presents the tasks and procedures that will be implemented to investigate and evaluate radiologically impacted sites in Parcel G at former Hunters Point Naval Shipyard (HPNS), San Francisco, California (**Figure 1-1**). Radiological surveys and remediation were previously conducted at HPNS as part of a basewide Time-critical Removal Action (TCRA). Tetra Tech EC, Inc. (TtEC), under contracts with the Department of the Navy (Navy), conducted a large portion of the basewide TCRA, including Parcel G. Data manipulation and falsification were committed by TtEC employees during the TCRA. An independent third-party evaluation of TtEC data identified evidence of manipulation, falsification, and data quality issues with data collected at Parcel G (Navy, 2017, 2018). As a result, the Navy will conduct investigations at radiologically impacted soil and building sites in Parcel G that were surveyed by TtEC (**Figure 1-2**). Future work plans will address soil and buildings in the other parcels (B, C, D-2, E, UC-1, UC-2, and UC-3), including the North Pier and Ship Berths.

The purpose of the investigation presented in this work plan is to determine whether site conditions are compliant with the remedial action objective (RAO) in the Parcel G Record of Decision (ROD) (Navy, 2009). The RAO for radiologically impacted soil and structures is to prevent receptor exposure to radionuclides of concern (ROCs) in concentrations that exceed remediation goals (RGs) for all potentially complete exposure pathways. Additional reference background areas (RBAs) will be identified to confirm, or update as necessary, estimates of naturally occurring and man-made background levels for ROCs not attributed to Naval operations at HPNS. A statistical comparison of site data to applicable reference area data will be conducted.

The lead agency at HPNS is the Navy, and the lead federal regulatory agency is the United States Environmental Protection Agency (USEPA). The Navy will continue to work with USEPA and the State of California throughout the planning and site investigation process.

The approach for collection and evaluation of data is based on the Parcel G ROD (Navy, 2009) and the Basewide Radiological Management Plan (TtEC, 2012). For soil, a phased approach was designed based on a proposal by the regulatory agencies to achieve a high level of confidence that ROD RGs have been met for soil (Attachment 2.1 in **Appendix A**). For Phase 1, 100 percent of soil will be re-excavated and characterized at 33 percent of trench units (TUs) associated with former sanitary sewers and storm drains in Parcel G. Soil sampling and scanning at the remaining 67 percent of TUs will be performed as part of Phase 2 to increase confidence that current site conditions comply with the Parcel G ROD RAO. The Navy will re-excavate 100 percent of Phase 2 TUs if contamination is identified in Phase 1 TUs. Because the survey design and implementation methods in this work plan are based on the regulators' proposal and their comments, the Basewide Radiological Management Plan (TtEC, 2012), and compliance with the RGs in the Parcel G ROD, only applicable elements of Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (USEPA et al., 2000) are incorporated.

The activities presented in this work plan will be conducted in accordance with this work plan, the sampling and analysis plan (SAP) (**Appendix B**), and a separate accident prevention plan/site safety and health plan (APP/SSHP). Specific procedures to ensure data quality and worker safety are described in the SAP and APP/SSHP. Project requirements, including personnel roles and responsibilities, required training, and health and safety protocols are presented in **Section 6**, based on CH2M HILL, Inc. (CH2M) and its subcontractor, Perma-Fix Environmental Services (Perma-Fix), leading and conducting the field activities. A separate contractor has been selected to conduct the work outlined in **Section 3**, and this work plan will be amended for contractor-specific information, as needed.

SECTION 2

Conceptual Site Model

This section provides an updated conceptual site model (CSM) (**Table 2-1**). The CSM summarizes the site description, history, and current status related to radiologically impacted buildings and former building areas, and former sanitary sewers and storm drains identified in the Historical Radiological Assessment (HRA) (NAVSEA, 2004). The sanitary sewers and storm drains were once a combined system identified as radiologically impacted because of the possibility that radioactive waste materials had been disposed of in sinks and drains, and the potential for the surrounding soil to be impacted by leakage and soil mixing during repairs. A removal action was initiated in 2006 to remove the sanitary sewers and storm drains. The removal action included excavation of overburden soil, removal of pipelines, plugging of open sanitary sewers and storm drains left in place during the removal process, ex situ radiological screening and sampling of the pipeline, and performance of final status surveys of the excavated soil and exposed excavation of trench surfaces. Soil was removed to a minimum of 1 foot below and to the sides of the sanitary sewer and storm drain piping.

Following the investigation and removal actions, there were allegations that TtEC potentially manipulated and falsely represented data, and some allegations have since been confirmed. In addition, the onsite laboratory used a screening method to analyze radium-226 (^{226}Ra) that may have reported at levels higher than actual radioactivity. TtEC presented CSMs in removal action completion reports that were based on potentially falsified data and screening results for ^{226}Ra reported by the onsite laboratory (results were biased high).

The results of additional investigation activities presented in this work plan will be used to update the CSM as needed.

Table 2-1. Conceptual Site Model

Site Name		Former Hunters Point Naval Shipyard (Parcel G)
Site Location		Located on San Francisco Bay near the southeastern boundary of San Francisco, California. HPNS encompasses approximately 848 acres, including approximately 416 acres on land, at the point of a high, rocky, 2-mile-long peninsula projecting southeastward into San Francisco Bay. Parcel G occupies 40 acres in the middle of HPNS (**Figure 1-1**).
Site Operations and History		• NRDL activities associated with analyzing samples from nuclear weapons tests, scientific studies (fallout, plant, animal, materials), and production and use of calibration sources. • The HRA also documents in Table 5-1 that the Navy had five radioactive licenses with the Atomic Energy Commission for ^{137}Cs, one for a quantity of 3,000 curies and a separate quantity of 20 curies of ^{137}Cs. Two licenses indicate that ^{137}Cs was in sources. In some cases, the Navy made its own sources with ^{137}Cs. • Use of radiography sources. • Use and potential disposal of radiological commodities, including discrete devices removed from ships (deck markers, radium dials) and welding rods. • Historical radiological material use documented in the HRA (NAVSEA, 2004) lists “impacted sites” – sites with potential for radioactive contamination. • Former surface soil impacted by fallout may be subsurface soil today because of fill activities.
Historical Site Conditions		Facility created from fill with some background levels of radionuclides (e.g., NORM and fallout). Dredge spoils from local berths were used as fill for some areas. Trenches were backfilled following removal of sewer lines. Trench backfill is mixed, but documentation of source is available (onsite fill, offsite fill, or mixture). Bay mud or bedrock marks bottom extent of fill material. Site drainage system was designed in the 1940s to discharge to San Francisco Bay and was separated into sanitary sewers and storm drains in 1958, 1973, and 1976, but never completed.
Potential Source Areas	**Potential Historical Sources of Radiological Contamination**	• Potential spills and releases from the following: – Storage of samples from nuclear weapons tests at various NRDL facilities – NRDL waste disposal operations: ▪ Liquid waste stored in tank and processed at Building 364 ▪ Animal research at Building 364 • Incidental disposal of radioluminescent commodities (e.g., dials, deck markers) during maintenance, individually or attached to equipment. • Leaking radiography and calibration sources could affect buildings listed in HRA Table 6-1 related to production and maintenance of calibration sources. • Small amounts of low-level radioactive liquid waste were authorized for release with dilution to sanitary sewers based on regulations in place at the time.

Table 2-1. Conceptual Site Model

	Release Areas in Parcel G	**Known Release Areas (from Section 6.4 of the HRA):** • Building 351A – Contaminated sinks and drain lines in Room 47 were removed • Buildings 317/364/365 Site – Peanut spill (small peanut-shaped spill adjacent to Building 364) – Liquid waste tanks removed – Contamination identified in yard and removed – Contaminated sinks and drain lines connected to the liquid waste tanks, not to the sanitary sewer, were removed **Potential Releases Identified after the HRA:** • Building 366 ventilation and potential releases to soil.

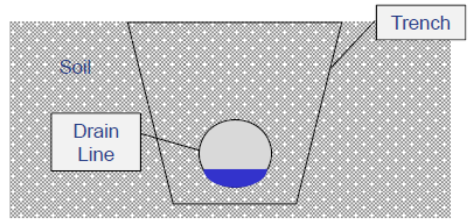
	Impacted Buildings in Parcel G	**Impacted Buildings with High Contamination Potential (from Table 8-2 of HRA):** • Building 364 (demolished) – Previously a concrete structure, measuring approximately 40 feet by 50 feet, used as an animal irradiation and research facility, for isotope processing and decontamination studies, and as a general research laboratory. Building 364 also contained a hot cell used to perform some of these processes. A liquid radioactive waste collection area was previously located at the rear of the building. Following closure of HPNS, it was leased to a laboratory company, which performed assay operations and has since been demolished. **Impacted Buildings with Moderate Contamination Potential (from Table 8-2 of HRA):** • Building 351 – Vacant three-story reinforced-concrete shop building with a five-story tower at the northwest corner, covering approximately 35,166 square feet of floor space. Building 351 was previously used as an electronics work area/shop, optical laboratories, Navy Bureau of Medicine and Surgery storeroom, machine shop (first floor), sampling laboratory, general research laboratories, and biological research laboratories. The NRDL also used the building as materials and accounts division, technical information division, office services branch, thermal branch, engineering division, and library. • Building 351A – Vacant one-story concrete building, covering approximately 35,166 square feet of floor space, constructed in 1952 over a crawl space that abuts the southern end of the building. Building 351A was used as a radiation detection, indication and computation repair facility and electronics shop for radiation detection equipment and a facility for the calibration, repair, and reconditioning of other instruments. The NRDL also used the building as a chemistry laboratory, applied research branch, administrative offices, nuclear and physical chemistry laboratory, and chemical technology division. • Building 366 – Vacant, one-story, raised-ceiling structure composed of an exterior “sheet metal” shell with interior room constructed of traditional wood and sheetrock materials, measuring approximately 280 feet by 130 feet. The building was built over a full-floor concrete pad with isolated areas of asphalt patching. Building 366 was used as administrative offices, applied research and technical development branches, radiological safety branch, management planning division, nucleonics division, instruments evaluation section, general laboratories, chemical research laboratory, shipyard radiography shop, boat/plastic shop, and other military/navy branch project officers station. NRDL also used the building for instrument calibration and management engineering and comptroller department. • Building 408 (demolished) – Previously a steel-framed structure enclosing two free-standing furnaces, used for smelting, that were constructed in 1947. The building was the equivalent of three stories at its northern end, dropping to one story at its southern end, and open-sided on the north. A firebrick-lined hearth occupied most of the open area at the north. Natural gas burners were present on the east and west sides of the hearth and a pair of smokestacks extended from the lower rear segment of the building. The building has been demolished, and the concrete building pad is all that remains. **Impacted Buildings with Low or No Contamination Potential (from Table 8-2 of HRA):** • Building 317 (demolished) – Previously a concrete structure measuring approximately 30 feet by 40 feet, used by NRDL personnel for temporary animal quarters. • Building 365 (demolished) – Previously a wooden structure with a concrete foundation that measured approximately 30 feet by 40 feet. Building 365 was

Table 2-1. Conceptual Site Model

		used as a personnel decontamination facility, change house, and storage building. The NRDL also used the building as a small animal facility. • Building 411 – Vacant curtain-walled, steel-framed building with a flat roof and includes a saw-toothed series of rooftop monitors as well as bands of steel industrial sash and large glazed industrial doors, measuring approximately 185,000 square feet. Building 411 was used for source storage, as a civilian cafeteria, shipfitters and boilermakers shop, and ship repair shop. A leading enclosure measuring approximately 25 feet by 15 feet was in the building and housed an x-ray machine used for radiography. **Buildings Identified after the HRA:** • Building 401 – Vacant two-story building measuring approximately 100 feet by 250 feet. Building 401 was previously utilized as a supply storehouse, trades shop, and general stores, and by public works as a maintenance shop and offices. In 2005, the civilian tenant had been made aware of the presence of gauges and dials containing ^{226}Ra and provided the gauges and dials to the Navy. • Building 439 – Vacant one-story building measuring approximately 250 feet by 400 feet. Building 439 was previously used by the Navy as an equipment storage facility. Following closure of HPNS, the building was leased by a skateboard company for use as a manufacturing and assembly plant. In 2002, Young Laboratories, a civilian tenant, was relocated to a 40-foot by 50-foot enclosed area in the northwest corner of the building with a separate outside entrance. Young Laboratories processed and analyzed metals and other materials containing metals as part of its assay operations. Previous investigations in Building 364 identified an old kiln that was assumed to have been used by Young Laboratories and a subsequent survey identified slag material inside containing ^{226}Ra. Additional surveys within Building 364 identified areas of elevated ^{137}Cs activity. The Navy identified Building 439 as potentially impacted based on potential cross-contamination from Building 364 during relocation. The Navy has found radiological contamination in portions of Parcel G, such as in the southeastern corner (associated with the buildings and the peanut spill) and in the sewers along Cochrane Street because of previous testing during the Phase I through Phase V radiological investigations/cleanups. The HRA indicates that ^{137}Cs was found at high concentrations in sediment from a manhole along Cochrane Street. The HRA documents that the Navy used ^{137}Cs, resulting in liquid waste releases in Building 364 in piping, sinks, and the peanut spill behind the building.
Radionuclides of Concern for Parcel G (from Table 8-2 of HRA)[4]		• ^{226}Ra • ^{137}Cs • ^{90}Sr • ^{60}Co (only for interior surfaces of former Buildings 364 and 365 and Building 411) • ^{232}Th (only building interior surfaces) • ^{235}U (only for interior surfaces of former Buildings 364 and 365) • ^{239}Pu (only for interior surfaces of Building 351A and former Buildings 364 and 365)

[4] The site-specific ROCs for the soil and building investigations are listed in **Table 3-4** and **Table 4-1**.

Table 2-1. Conceptual Site Model

Potential Migration Pathways	• Releases to soil and air.
	• Releases to sanitary sewer lines.
	  – Buildings with known releases
	• Releases to storm drains.
	  – Incomplete separation from sanitary sewer lines
	• Runoff from surface spills.
	• Releases from potentially leaking storm drain and sanitary sewer lines to surrounding soil (now removed).
	• Release of sediments from breaks or seams during power washing of drain lines.
	
	
	Conceptual Cross Section of Drain Lines

Potential Exposure Pathways	• Soil:
	  – External radiation from ROCs
	  – Incidental ingestion and inhalation of soil and dust with ROCs for intrusive activities disturbing soil beneath the durable cover (only construction worker receptor)
	• Building surfaces:
	  – External radiation from ROCs
	  – Inhalation and incidental ingestion of resuspended radionuclides

Current Status	• HPNS is not an active military installation. In 1991, HPNS was selected for closure pursuant to the terms of the Defense BRAC Act of 1990. For more than 20 years, the Navy leased many HPNS buildings to private tenants and Navy-related entities for industrial and artistic uses. Current leases include art studios and a police department facility. Parcels A, D-2, UC-1, and UC-2 have been transferred to the City and County of San Francisco for nondefense use, and the remaining areas of HPNS are also planned to be transferred.
	• All known sources removed by Navy using standards at the time.
	  – Follow-up investigations resulted in removal of small volumes of soil to meet current RGs
	• Sanitary sewer and storm drain removal investigation conducted at Parcel G from 2007 to 2011.
	  – More than 4 miles of trench lines and 50,000 cubic yards of soil investigated and disposed of or cleared for use as onsite fill
	  – Trench excavations that have been backfilled now contain homogenized soil from onsite fill, offsite fill, or a mixture of both

Table 2-1. Conceptual Site Model

Uncertainties	• Lower potential for radiological contamination than originally described in historical CSMs based on the following lines of evidence: – Known sources have been removed. – Sanitary sewers and storm drains, and 1 foot of soil surrounding the pipe removed to the extent practicable. The sewer lines were removed to within 10 feet of all buildings. Impacted buildings had remaining lines removed during surveys of the buildings. Non-impacted buildings had surveys performed at ends of pipes, and pipes were capped. – Any residual concentrations may be modified by radiological decay (shorter-lived radionuclides, such as ^{137}Cs and ^{90}Sr) or remobilization (including weathering and migration). – Sediment data from inside pipe not indicative of a large quantity disposal or contamination (maximum ^{226}Ra concentration of 4.2369 pCi/g and maximum ^{137}Cs concentration of 0.87795 pCi/g in Parcel G). – Overestimate of ^{226}Ra concentrations in soil by the onsite laboratory using an imprecise measurement method. – LLRW bins were tested by the Navy's independent waste broker at an offsite laboratory using 5-point composites, and only 3 out of 1,411 bins had results with ^{226}Ra above the RGs. • Data manipulation or falsification. • Data quality deficiencies. • ^{137}Cs and ^{90}Sr are present at HPNS because of global fallout from nuclear testing or accidents, in addition to being potentially present as a result of Navy activities. Because of backfill activities, ^{137}Cs and ^{90}Sr from fallout and Navy activities are not necessarily only on the surface and may be present in both surface and subsurface soil. • Potential for isolated radiological commodities randomly distributed around the site. • Trenches where scan data exceeded the IL and biased soil samples were not collected.

Notes:
^{60}Co = cobalt-60
^{90}Sr = strontium-90
^{137}Cs = cesium-137
^{232}Th = thorium-232
^{235}U = uranium-235
^{239}Pu = plutonium-239
BRAC = Base Realignment and Closure
IL = investigation level
LLRW = low-level radioactive waste
NORM = naturally occurring radioactive material
NRDL = Navy Radiological Defense Laboratory
pCi/g = picocurie(s) per gram

SECTION 3

Soil Investigation Design and Implementation

This section describes the data quality objectives (DQOs), ROCs, RGs, ILs, and radiological investigation design and implementation for Parcel G soil.

3.1 Data Quality Objectives

The DQOs for the soil investigation are as follows:

- **Step 1-State the Problem**: Data manipulation and falsification were committed by a contractor during past sanitary sewer and storm drain removal actions and current and former building investigations for soil. The Technical Team evaluated soil data and found evidence of potential manipulation and falsification. The findings call into question the reliability of soil data and there is uncertainty whether radiological contamination was present or remains in place. Therefore, the property is unable to be transferred as planned. Based on the uncertainty and the description of radiological activities in the HRA, there is a potential for residual radioactivity to be present in soil.
- **Step 2-Identify the Objective**: The primary objective is to determine whether site conditions are compliant with the Parcel G ROD RAO (Navy, 2009).
- **Step 3-Identify Inputs to the Objective**: The inputs include surface soil and subsurface soil analytical data for the applicable ROCs and gamma scan survey measurements to identify biased soil sample locations. RBA surface and subsurface soil analytical data for ROCs will also be used to confirm, or update as necessary, estimates of naturally occurring and man-made background levels for ROCs not attributed to Naval operations at HPNS.
- **Step 4-Define the Study Boundaries**: See Phases 1 and 2 TUs and survey units (SUs) listed in **Tables 3-1 through 3-3** and shown on **Figure 3-1**.
- **Step 5-Develop Decision Rules:**
  - If the investigation results demonstrate that there are no exceedances determined from a point-by-point comparison with the statistically-based RGs[5] at agreed upon statistical confidence levels, or that residual ROC concentrations are NORM or anthropogenic background, then a remedial action completion report (RACR) will be developed.
  - If the investigation results demonstrate exceedances of the RGs determined from a point-by-point comparison with the statistically-based RGs[5] at agreed upon statistical confidence levels and are not shown to be NORM or anthropogenic background, remediation will be conducted, followed by a RACR. Remediation will be based on the following:
    - If one Phase 1 TU does not meet the Parcel G ROD RAO, all Phase 2 TUs will be excavated.
    - If all Phase 1 TUs meet the Parcel G ROD RAO, Phase 2 will be initiated for TUs.
    - If any Former Building Site SU, Crawl Space soil SU, or Phase 2 TU does not meet the Parcel G ROD RAO, the SU or TU will be excavated.
  - The RACR will describe the results of the investigation, explain remediation performed, compare the distribution of data from the sites with applicable reference area data, and provide a demonstration that site conditions are compliant with the Parcel G ROD RAO through the use of

[5] The RGs are statistically based because they are increments above a statistical background.

multiple lines of evidence including application of statistical testing with agreed upon statistical confidence levels on the background data.

- **Step 6-Specify the Performance Criteria:** The data evaluation process for demonstrating compliance with the Parcel G ROD RAO is presented in **Section 5** and depicted on **Figure 3-2**.
  - Compare each ROC concentration for every sample to the corresponding RG presented in **Section 3.3**.
    - If all concentrations for all ROCs for all samples are less than or equal to the RGs, then compliance with the Parcel G ROD RAO is achieved.
  - Compare sample data to appropriate RBA data from HPNS as described in **Section 5**. Multiple lines of evidence will be evaluated to determine whether site conditions are consistent with NORM or anthropogenic background. The data evaluation may include, but is not limited to, population-to-population comparisons, use of a maximum likelihood estimate (MLE) or background threshold value (BTV), graphical comparisons, and comparison with regional background levels.
    - If all residual ROC concentrations are consistent with NORM or anthropogenic background, site conditions comply with the Parcel G ROD RAO.
    - If any ^{226}Ra gamma spectroscopy concentration exceeds the ^{226}Ra RG and the range of expected NORM concentrations, then the soil sample will be analyzed using alpha spectroscopy for uranium isotopes (^{238}U, ^{235}U, and ^{234}U), thorium isotopes (^{232}Th, ^{230}Th, and ^{228}Th), and ^{226}Ra to evaluate equilibrium conditions. If the concentrations of radionuclides in the uranium natural decay series are consistent with the assumption of secular equilibrium, then the ^{226}Ra concentration is NORM, and site conditions comply with the Parcel G ROD RAO.
  - If any result is greater than the RG and cannot be attributed to NORM or anthropogenic background, remediation will be performed prior to backfill.
- **Step 7-Develop the Plan for Obtaining Data:**
  - Phase 1 TUs – The radiological investigation will be conducted on a targeted group of 21 of the 63 TUs (from 1 to 22 feet deep) associated with former sanitary sewers and storm drains in Parcel G (see **Figure 3-1**). For Phase 1 TUs, the durable cover (including asphalt, asphalt base course, concrete, gravel, debris, or obstacles) will be removed to expose the target soils. Soil will be excavated to the original TU boundaries, as practicable. Following excavation to the original TU boundaries, additional excavation of approximately 6 inches of the trench sidewalls and floors will be performed to provide ex-situ scanning and sampling of the trench sidewalls and floors. Excavated soil will be 100 percent gamma scanned by one of two methods: soil may be laid out on Radiological Screening Yard (RSY) pads for a surface scan, or soil may be processed and scanned using automated soil segregation technology. Systematic and biased samples will be collected from the excavated soil for offsite analysis.
  - Phase 2 TUs – Additional gamma scan surveys and soil sampling will be conducted on the remaining 42 TUs (from 1 to 22 feet deep) associated with former sanitary sewers and storm drains in Parcel G (see **Figure 3-1**). Each Phase 2 TU will undergo a 100 percent radiological surface gamma scan of accessible areas, along with soil sample collection via borings from soil within the former trench boundaries and from soil representing the former trench walls and floors, as practicable. Prior to the survey, the durable cover (including asphalt, asphalt base course, concrete, gravel, debris, or obstacles) will be removed to expose the target soils. The borings will be advanced approximately 6 inches below the depth of previous excavation and will be gamma scanned upon retrieval. Phase 2 will only be performed if no contamination is

found during Phase 1. If contamination is found during Phase 1, then all of the Phase 2 TUs will be excavated and investigated in a manner similar to that used for the Phase 1 TUs.

- Former Building Site and Crawl Space Soil SUs – The radiological investigation will be conducted at the 28 SUs[6] associated with surface soil at building sites in Parcel G (see **Figure 3-1**). The SUs will be investigated by conducting a 100 percent gamma scan of the surface soil, along with sample collection from systematic and biased locations. Systematic and biased samples will be collected from the excavated soil for offsite analysis.
  - At the Former Buildings 317/364/365 Site, SUs 27 (peanut spill) and 28 (liquid waste transfer system [LWTS]) will be excavated to 2 and 10 feet below ground surface (bgs), respectively, for consistency with the previous excavation boundaries. The two SUs will be excavated to the original excavation boundaries, as practicable, and gamma scans of the excavated material will be conducted, similar to that used for the Phase 1 TUs. Excavated soil will be gamma-scanned by one of two methods. Soil may be laid out on RSY pads for a surface scan, or soil may be processed and scanned using soil segregation technology. Following excavation to the original SU boundaries, additional excavation of approximately 6 inches of the trench sidewalls and floors will be performed to provide ex situ scanning and sampling of the trench sidewalls and floor.
- The soil samples collected will be analyzed for the applicable ROCs by accredited offsite laboratories, and the results will be evaluated as described in Step 6. The excavated soil from within each trench and the over-excavation will be tracked separately, and global positioning system (GPS) location-correlated results will be collected or surveying conducted.

3.2 Radionuclides of Concern

The ROCs for Parcel G soil are based on the HRA (NAVSEA, 2004) and ROD (Navy, 2009) as presented in **Table 3-4**.

Table 3-4. Soil Radionuclides of Concern

Soil Area	Radionuclide of Concern
Former Sanitary Sewer and Storm Drain Lines	^{137}Cs, ^{226}Ra, ^{90}Sr
Former Buildings 317/364/365 Site	^{137}Cs, ^{226}Ra, ^{90}Sr, ^{239}Pu, ^{235}U
Building 351A Crawl Space	^{137}Cs, ^{226}Ra, ^{90}Sr, ^{239}Pu, ^{232}Th

3.3 Remediation Goals

The soil data from the radiological investigation will be evaluated to determine whether site conditions are compliant with the RAO in the Parcel G ROD (Navy, 2009). The RAO is to prevent exposure to ROCs in concentrations that exceed RGs for all potentially complete exposure pathways. The RG for each ROC is presented in **Table 3-5**. The soil data will be compared to the applicable RGs using a single sample comparison and evaluated as described in **Section 5**.

[6] Previously, 32 SUs were investigated at the Former Buildings 317/364/365 Site and Building 351A Crawl Space; however, some SU areas overlapped. For the Former Buildings 317/364/365 Site, former SU 22 overlaps TU 153 and will be investigated as part of TU 153. For the Building 351A Crawl Space, former SU R, SU S, and SU U overlap SU M, SU N, and SU O and will be investigated as SU M, SU N, and SU O.

Table 3-5. Soil Remediation Goals from Parcel G ROD

Radionuclide	Residential Soil Remediation Goal[a] (pCi/g)
^{137}Cs	0.113
^{239}Pu	2.59[b]
^{226}Ra	1.0
^{90}Sr	0.331

[a]All RGs will be applied as concentrations above background.
[b] ^{239}Pu is an ROC only for the Former Buildings 317/364/365 Site.

3.3.1 Investigation Levels

ILs are media-specific or instrument-specific measurements that trigger a follow-up response, such as further investigation, if exceeded.

ILs are expressed in units of the instrument's response (such as counts per minute [cpm]) that are used to indicate when additional investigations (**Section 5**) are required. ILs are established for each instrument and vary with measurement type (e.g., scan, static). Scan survey measurements will be flagged when they exceed ILs.

For gamma scan survey measurements collected, individual measurement results above the IL will prompt investigations that may result in the collection of biased samples or additional field measurements to determine the areal extent of the elevated activity. Potential causes of elevated gamma scanning measurements may include discrete radioactive objects (e.g., deck markers), localized soil contamination, measurement geometry effects, and NORM. Ex situ gamma scan surveys will be performed using detector systems equipped with gamma spectroscopy to provide real-time radionuclide-specific measurements. The spectra will be evaluated using region of interest (ROI)-peak identification tools for the ROCs that correspond to gamma rays at 186 kiloelectron volts (keV) for ^{226}Ra, 609 keV for ^{226}Ra daughter bismuth-214 (^{214}Bi), 662 keV for ^{137}Cs, and other gamma emissions associated with the uranium and thorium decay series. The gamma scanning system will detect ^{137}Cs photons; however, individual measurements are not intended to characterize ^{137}Cs at or below the RG. In addition, gross gamma energy windows may be used to identify radiological anomalies that are not readily identified with a single gamma energy, such as the bremsstrahlung radiation from a deck marker containing ^{90}Sr.

The gamma spectroscopy detector system also may be used to assess gamma scan investigation locations using a 1-minute or greater static count and spectral analysis to compare the activity at a specific point to background. For gamma scan investigations, the net spectrum will be plotted and the critical levels assessed for ROC-specific energy ranges to find out if there is any activity present above background. Critical levels, as defined in the MARSSIM Section 6.7.1, represent thresholds above which net counts are statistically greater than background (USEPA et al., 2000). If the gamma spectroscopy detector system static measurements identify elevated locations, biased samples will be collected; otherwise, the static count spectra will be provided in the data reports. The analysis of scanning data collected by the RS-700 system and triggers for further investigation are described in **Section 3.5.1.1**. ILs for other field instrumentation are typically equal to an upper estimate of the instrument- and material-specific background, such as the mean plus three standard deviations. Appropriate instrument and site-specific gamma scan ILs for site ROC and gross gamma (i.e., full-energy spectrum) measurements will be determined following mobilization.

Section 3.5 describes the minimum gamma scan survey instrument requirements and the methodology to determine instrument soil scan minimum detectable concentrations (MDCs) in soil.

3.4 Radiological Investigation Design

This section describes the design of the radiological investigation, including gamma scan surveys and soil sampling. The radiological investigation design is primarily based on methods, techniques, and instrument systems in the Basewide Radiological Management Plan (TtEC, 2012) with the ultimate requirement to demonstrate compliance with the Parcel G ROD RAO (Navy, 2009). The SAP (**Appendix B**) provides additional guidance on soil sampling, chain-of-custody, laboratory analysis, and quality assurance (QA)/quality control (QC) requirements.

There are two types of Parcel G soil investigations discussed in this section to include surveys of:

- Surface and subsurface soil associated with former sanitary sewer and storm drain lines (TUs)
- Surface soil areas associated with soil from building sites (SUs)

A phased investigation approach is planned for surface and subsurface TU soil associated with former sanitary sewer and storm drain lines. Phase 1 includes the radiological investigation of 21 previously established TUs and Phase 2 includes the remaining 42 TUs in Parcel G. The approach is based on a proposal by the regulatory agencies to achieve a high level of confidence that the Parcel G ROD RAO has been met for soil (Attachment 2.1 in **Appendix A**). For Phase 1, 100 percent of soil will be re-excavated and characterized at 33 percent of TUs in Parcel G. Soil sampling and scanning at the remaining 67 percent of TUs will be performed as part of Phase 2 to increase confidence that current site conditions comply with the Parcel G ROD RAO. The Navy will re-excavate 100 percent of Phase 2 TUs if contamination is identified in Phase 1 TUs. For both Phase 1 TUs and Phase 2 TUs, the durable cover (including asphalt, asphalt base course, concrete, gravel, debris, or obstacles) will be removed to expose the target soils.

For surface soil areas associated with soil from building sites, radiological investigation will be conducted at the 28 SUs[7] in Parcel G.

The principal features of the investigation protocol to be applied to the Parcel G soil TUs and SUs are discussed herein and include the following:

- Number of samples
- Locating samples
- Establishing radiological background
- TU design
- SU design

To the extent possible, manual data entries will be reduced or eliminated through use of electronic data collection and transfer processes.

3.4.1 Number of Samples

Soil samples will be collected on a systematic sampling grid and/or from biased locations identified by the gamma scanning surveys. The number of systematic soil samples collected will be based on the guidance described in MARSSIM Section 5.5.2.2 (USEPA et al., 2000) using ^{226}Ra as the example basis for calculating the minimum sample frequency. Even if the MARSSIM-recommended or other statistical tests are not used to evaluate site data, these calculations serve as a basis for determining the number

[7] Previously, 32 SUs were investigated at the Former Buildings 317/364/365 Site and Building 351A Crawl Space; however, some SU areas overlapped. For the Former Buildings 317/364/365 Site, former SU 22 overlaps TU 153 and will be investigated as part of TU 153. For the Building 351A Crawl Space, former SU R, SU S, and SU U overlap SU M, SU N, and SU O and will be investigated as SU M, SU N, and SU O.

of samples per SU to be collected. The number of biased samples will be determined based on results of scan surveys, and a minimum of one biased sample will be collected in every TU and SU.

MARSSIM Section 5.5.2.2 defines the method for calculating the number of soil samples when residual radioactivity is uniformly present throughout an SU. Therefore, determining the number of samples will be based on the following factors:

- RG for radioactivity in soil (upper boundary of the gray region [UBGR])
- Lower boundary of the gray region (LBGR)
- Estimate of variability (standard deviation [σ]) in the reference area and the SUs
- Shift (Δ=UBGR-LBGR)
- Relative shift ([UBGR-LBGR]/σ) (see **Equation 3-1**)
- Decision error rates for making a Type I or Type II decision error that the mean or median concentration exceeds the RG (determined via MARSSIM Table 5.2)

Each of the preceding factors is addressed in the following paragraphs. Example data are provided to assist in explaining the process for calculating the minimum sample frequency. Actual numbers of samples for SUs will be based on reference area data once they become available. The data quality assessment (DQA) of SU data will include a retrospective power curve (based on the MARSSIM Appendix I guidance) to demonstrate that a sufficient number of samples was collected to meet the project objectives.

The ^{226}Ra RG is defined as 1 pCi/g plus background. As a basis for the calculations, the background ^{226}Ra soil concentration is assumed to be 1 pCi/g.

MARSSIM defines a gray region as the range of values in which the consequences of decision error on whether the ^{226}Ra concentration is less than or exceeds the RG are relatively minor. The RG of 1 pCi/g of ^{226}Ra above background (1 pCi/g) was selected to represent the UBGR (2 pCi/g). The LBGR is the median concentration in the SU, and the retrospective power will be determined after the survey is completed. Given the absence of data prior to performing the investigation activities, MARSSIM Section 2.5.4 suggests arbitrarily selecting the LBGR as half the RG. Therefore, for this example, the LBGR = 0.5 pCi/g + 1 pCi/g = 1.5 pCi/g. Assuming the UBGR equals the RG, then Δ = 0.5 pCi/g for this example.

MARSSIM defines σ as an estimate of the standard deviation of the measured values in the SU. Because SU data will not be available until the investigation activities are completed, MARSSIM recommends using the standard deviation of the RBA as an estimate of σ. Given the absence of data prior to performing the investigation activities, an arbitrary value of 0.25 pCi/g has been selected as an estimate of σ for this example.

The relative shift is calculated based on MARSSIM guidance (Section 5.5.2.2) as shown in the following equation:

Equation 3-1

$$\frac{\Delta}{\sigma} = \frac{(UBGR - LBGR)}{\sigma} = \frac{(RG - LBGR)}{\sigma} = \frac{(2.0 - 1.5)}{0.25} = 2.0$$

The minimum number of samples assumes the ^{226}Ra concentration in the SU exceeds the RG. Type I decision error is deciding that the ^{226}Ra concentration in the SU is less than the RG when it actually exceeds the RG. To minimize the potential for releasing soil with concentrations above the RG, the Type I decision error rate is set at 0.01. Type II decision error is deciding that the ^{226}Ra concentration exceeds the RG when it is actually less than the RG. To protect against remediating soil with concentrations below the RG, the Type II decision error rate is set at 0.05.

MARSSIM Table 5.3 lists the minimum number of samples to be collected in each SU and RBA based on the relative shift and decision error rates. For a relative shift of 2, with a Type I decision error rate of 0.01 and Type II decision error rate of 0.05, MARSSIM Table 5.3 recommends a minimum of 18 samples in each SU and RBA. For example, for Phase 1, a minimum of 18 samples would be collected for every 152 cubic meters (m^3) of soil (calculation provided in **Section 3.4.4.2**).

The USEPA has requested that a minimum of 25 samples be collected in each survey unit. Therefore, 25 samples will be a placeholder until data from the RBA study become available. The minimum number of samples per SU will be developed based on the variability observed in the RBA data. A retrospective power curve will be prepared to demonstrate that the number of samples from each SU was sufficient to meet the project objectives. If necessary, additional samples may be collected to comply with the project objectives.

3.4.2 Locating Samples

Systematic soil samples will be located using Visual Sample Plan (VSP) software (or equivalent). Each TU or SU will be mapped in VSP, such that at a minimum, 18 systematic soil samples will be collected in each TU or SU. The systematic soil samples will be plotted using a random start triangular grid using the VSP software with GPS coordinates for each systematic sample.

3.4.3 Radiological Background

The RGs presented in **Table 3-5** are incremental concentrations above background; therefore, RBA samples and measurements will be collected and evaluated to provide generally representative data sets estimating natural background and fallout levels of man-made radionuclides for the majority of soils at HPNS. The RBA characterization will incorporate three survey techniques: gamma scans, surface soil sampling, and subsurface soil sampling to support data evaluations. The details on soil locations, surveying, sampling, and data evaluation are presented in the Soil RBA Work Plan (**Appendix C**).

3.4.4 Phase 1 Trench Unit Design

Radiological investigations will be conducted on a targeted group of 21 of the 63 TUs associated with former sanitary sewer and storm drain lines (**Figure 3-1**). The former TUs selected for Phase 1 investigation were based on their location adjacent to (downstream/upstream) impacted buildings and considered the recommendations from the Radiological Data Evaluation Findings Report (Navy, 2017). The name, size, and boundary of the TUs will be based on the previous plans and reports (**Table 3-1**).

The Phase 1 TUs will be re-excavated to the previous excavation limits by making reasonable attempts to ensure accuracy in relocating the former TU boundaries (see **Section 3.6.3**). The excavated soil material will be investigated by gamma scan surveys and systematic and biased soil sample collection following either the automated soil sorting system process (**Section 3.6.3.1**) or the RSY process (**Section 3.6.3.2**). If the investigation results from the gamma scan surveys and results from the analysis of systematic and biased soil samples demonstrate potential exceedances of the RGs and background, the material will be segregated for further evaluation as described in **Section 5.3**.

To address the Phase 1 radiological investigations of the former trench sidewalls and floors, a strategy to not only excavate the former trenches to the previous excavation limits, but to over-excavate at least an additional 6 inches outside the estimated previous boundaries of the sidewalls and bottom will be employed. The exhumed over-excavated material will represent the trench sidewalls and bottom and will be gamma scan-surveyed and sampled ex situ, to provide the following benefits:

- Significant improvement of the measurement quality for gamma scan surveys by controlling the measurement geometry.
  - Material thickness will not exceed 6 inches

  - Use of large-volume sodium iodide (NaI) detectors with shielding
  - Use of large-volume NaI detectors with spectroscopy

- Reducing the potential safety risks associated with in situ trench sidewall and bottom scanning and sampling.
- Reducing the water management required to de-water trenches to provide unsaturated material to investigate.
- Increasing assurance that all potentially impacted materials are investigated because of the inherent limitations of finding exact boundaries.

The over-excavated material (representing sidewalls and floors) will be investigated in the same fashion as the excavated soil by gamma scan surveys and soil sample collection by soil sorting system process (**Section 3.6.3.1**) or RSY process (**Section 3.6.3.2**). The over-excavated material representing trench sidewalls and floors will be maintained as separate volumes (e.g., piles) of soil from the original excavated soil. If the investigation results from the gamma scan surveys and results from the analysis of systematic and biased soil samples of the over-excavated material demonstrate exceedances of the RGs and background, the material will be segregated for further evaluation. An in situ investigation of the trench sidewalls and floor will be performed as described in **Section 5.3**. An example Phase 1 TU location is presented on **Figure 3-3**.

3.4.4.1 Nomenclature of Phase 1 Trench Units

The former TUs will be excavated and characterized in “batches” that will be given new unique identifiers at the time of excavation by the geologist or radiation technician. Excavated material representing the backfill material from former TUs will use the following nomenclature format:

AABB-ESU-NNNA

Where: AA = facility (HP for Hunters Point will be used in this work plan)

BB = site location (PG for Parcel G will be used in this work plan)

ESU = excavation soil unit

NNN = former trench unit number

A = alpha-numeric digit of each “batch” (beginning with A, in sequential order)

For example, the third “batch” of backfill TU material excavated from the former TU 69 will be identified as follows:

HPPG-ESU-069C

In this example, “HPPG” identifies Hunters Point Parcel G, “ESU” identifies excavation soil unit, “NNN” identifies the unit as being excavated from the former Trench Unit 69, and “C” represents the third unit created from excavating this former TU.

Excavated material representing the sidewalls and bottoms of former TUs will use the following nomenclature format:

AABB-SFU-NNNA

Where: AA = facility (HP for Hunters Point will be used in this work plan)

BB = site location (PG for Parcel G will be used in this work plan)

SFU = sidewall floor unit

NNN = former trench unit number

A = alpha-numeric digit of each "batch" (beginning with A, in sequential order)

For example, the first "batch" of sidewall and floor material excavated from the former TU 153 will be identified as follows:

HPPG-SFU-153A

In this example, "SFU" identifies sidewall floor unit, "NNN" identifies the unit as being excavated from the former Trench Unit 153, and "A" represents the first unit created from excavating this former trench unit.

3.4.4.2 Size of Phase 1 Trench Units

RSY pads are designed to be approximately 1,000 square meters (m^2) (TtEC, 2009d, 2012). Using the assumption that material will be assayed in geometries yielding soil column thickness of 6 inches, the volume of a "batch" of excavated material (either ESU or SFU) is calculated as:

$$1000m^2 \times 0.1524m\ (6\ inches) = 152m^3$$

Therefore, an individual ESU or SFU volume will not exceed 152 m^3. Converting from m^3 to tons of soil (a more commonly used unit), the maximum "batch" size of excavated material will not exceed:

$$152m^3 \times \frac{1.3yd^3}{m^3} \times \frac{2{,}200lbs\ soil}{yd^3} \times \frac{1ton}{2{,}000lbs} \approx 217\ tons\ soil$$

This calculation assumes 2,200 pounds of loose soil per cubic yard, actual field conditions may vary from this assumption. Each former TU will be excavated and managed in no larger than approximately 152 m^3 "batches" (i.e., ESUs or SFU) and individually stockpiled prior to radiological screening. Using a maximum size of 152 m^3, the estimated number of expected ESUs created during the excavation of backfill from former TUs are listed in **Table 3-1**. Similarly, using a maximum size of 152 m^3, the estimated number of expected SFUs created during the over-excavation of former TUs (representing sidewalls and floors) are listed in **Table 3-1**.

The actual sizes of individual ESUs and SFUs will be determined in the field, based on the actual final excavation limits and volumes of soil material excised from the former trenches.

3.4.5 Phase 2 Trench Unit Design

The Phase 2 TUs are listed in **Table 3-2** and depicted on **Figure 3-1**. Investigations of the Phase 2 TUs will consist of a combination of gamma scan surveys and soil samples.

Each Phase 2 TU will undergo a 100 percent radiological surface gamma scan of accessible areas using an appropriate instrument listed in **Section 3.5**. The instrument will be composed of a gamma scintillation detector equipped with a spectroscopy system that measures gross gamma counts along with radionuclide-specific measurements and is coupled to a data logger that logs the count rate data in conjunction with location. Gross gamma and gamma spectra obtained during the surface gamma scan surveys will be analyzed using region-of-interest peak identification tools for the ROCs. Elevated areas will be noted on a survey map and flagged in the field for verification. Manual scans using a handheld instrument may be performed to further delineate suspect areas in the TU. Biased samples will be collected from potential areas of elevated activity displaying gamma scan survey results greater than the ILs (**Section 5.3.1**).

Within the backfill of each previous TU boundary, VSP software (or equivalent) will be used to determine the systematic soil boring locations (as determined in **Section 3.4.1**). A stylized graphic of an example Phase 2 TU with 18 systematic boring locations placed using a triangular grid is shown on **Figure 3-4**. Each location will be cored down to approximately 6 inches below the depth of previous excavation. Each retrieved core will be scan-surveyed along the entire length of the core. Scan measurement results of the retrieved core will be evaluated to investigate the potential for small areas of elevated activity in the fill material. A sample will be collected from the top 6 inches of material, and a second sample will be collected from the 6 inches of material just below the previous excavation depth. Additionally, a third sample will be collected from the core segment with the highest scan reading that was not already sampled. At least three samples will be collected from each of the 18 borings, for a total of 54 samples per previous TU boundary. The anticipated number of subsurface soil samples is shown in **Table 3-2**; however, additional locations or samples may be required based on the evaluation following analysis of RBA data.

In addition, systematic cores will be placed every 50 linear feet on each trench sidewall in order to collect samples from locations representative of the trench sidewalls. The systematic boring locations will be located approximately 6 inches outside of the previous sidewall excavation limits and will extend 6 inches past the maximum previous excavation depth on both sidewalls in every trench. In the same fashion described in the previous paragraph, core sections will be retrieved, scanned, and sampled such that at least three samples will be collected from each of the boring locations. The projected number of borings and soil samples obtained from sidewall material is presented in **Table 3-2**. The typical sample locations representing the TU sidewalls are shown on **Figure 3-4**. The subsurface soil sampling process is detailed in **Section 3.6.4.1**. The soil samples will be submitted to the offsite analytical laboratory for analysis according to the SAP (**Appendix B**).

3.4.6 Former Building Site and Crawl Space Survey Unit Design

Radiological investigations will be conducted at the 28 SUs associated with soil from building sites where only surface soil scanning and sampling was previously conducted (**Figure 3-1**). The name, size, and boundary of the SUs will be based on the previous plans and reports (**Table 3-3**).

Each surface SU will undergo a 100 percent radiological surface gamma scan of accessible areas using an appropriate instrument listed in **Section 3.5**. The instrument will be composed of a gamma scintillation detector equipped with spectroscopy coupled to a data logger that logs the resultant data in conjunction with location. Gross gamma and gamma spectra obtained during the surface gamma scan surveys will be analyzed using ROI-peak identification tools for the ROCs. Elevated areas will be noted on a survey map and flagged in the field for verification. Manual scans using a handheld instrument may be performed to further delineate suspect areas in the SU. Biased samples will be collected from potential areas of elevated activity displaying gamma scan survey results greater than the IL (**Section 5.3.1**).

Following the completion of the gamma scan surveys, the SU area will be plotted using VSP software (or equivalent) to determine the location of systematic samples. A stylized graphic of an example SU with 18 systematic samples placed using a triangular grid is shown on **Figure 3-4**. The surface soil sample collection process is detailed in **Section 3.6.5.1**. The soil samples collected from each SU will be submitted to the offsite analytical laboratory for analysis according to the SAP (**Appendix B**).

At the Former Buildings 317/364/365 Site, SUs 27 (peanut spill) and 28 (LWTS) will be excavated to 2 and 10 feet bgs, respectively, <u>for consistency with the previous excavation boundaries</u> (**Figure 3-1**). The two SUs will be excavated to the original excavation boundaries, as practicable, and gamma scans of the excavated material will be conducted similar to that used for Phase 1 TUs, discussed in **Section 3.4.4**.

3.5 Instrumentation

Radiation instruments, consistent with Basewide Radiological Management Plan (TtEC, 2012), have been selected to perform measurements in the field. Specifics related to radiological investigation implementation are provided in **Section 3.6**. The laboratory instruments used to analyze the soil samples and the associated standard operating procedures (SOPs) for calibration, maintenance, testing, inspection, and QA/QC are discussed in the SAP (**Appendix B**).

The following instrumentation information is included in this section:

- Soil gamma scanning instruments
- Instrument detection calculations
- Calibration
- Daily performance checks

Instruments that are expected to be used during fieldwork for activities other than soil gamma scan surveys are described in **Section 6.5**.

3.5.1 Soil Gamma Scanning Instruments

The gamma scanning survey instruments should be selected to provide a high degree of defensibility and based on their capability to measure and quantify gamma radiation and position using the best available technology. The primary gamma scanning instrument that will be used during Phase 2 TU surface scan surveys, soil scan surveys of excavated trench soil (either following the RSY or soil sorting processes), and soil area SUs will consist of NaI or plastic scintillation detectors equipped with automated data logging. The gamma scan survey system will be equipped with gamma spectroscopy capabilities, providing the benefit of collecting spectral measurements in addition to the gross gamma measurements. The spectra will be evaluated using ROI-peak identification tools for the ROCs that correspond to gamma rays at 186 keV for ^{226}Ra, 609 keV for ^{226}Ra daughter ^{214}Bi, 662 keV for ^{137}Cs, and a gross gamma window (i.e., full energy spectrum). Details on the evaluation of ROIs and gross gamma windows for the RS-700 system are provided in **Section 3.5.1.1**.

For gamma scan surveys conducted on the Phase 2 TU surfaces, in the RSY pads, and in the surface soil area SUs, the gamma scanning instrument will also be equipped with a positioning sensor and software that is able to simultaneously log continuous radiation and position data. The gamma radiation measurement will be coupled to the position measurement to allow for precise visualization of the data set. For gamma scan surveys of retrieved cores, a gamma instrument consisting of a NaI detector equipped with gamma spectroscopy. The instruments that are expected to be used during fieldwork are listed in **Table 3-6**.

Table 3-6. Gamma Survey Instruments

Meter Manufacturer and Model	Detector Manufacturer and Model	Detector Type	Use
Radiation Solutions, Inc RS-700	RSI RSX-1	4-liter NaI(Tl) detectors (2)	Ex situ RSY and soil area gamma scan surveys
Ludlum 2221, Multi-channel Analyzer	Ludlum Model 44-20	3 inches x 3 inches NaI(Tl) detector	Soil area gamma scans, sample screening, soil core surveys
Automated Soil Sorting System	To Be Determined	Large-volume NaI(Tl) detector	Gamma soil surveys in soil sorting system

Notes:

Equivalent alternative instrumentation may be used following approval by the PRSO and Field Team Lead.

NaI(Tl) = sodium iodide activated with thallium

PRSO = Project Radiation Safety Officer

3.5.1.1 RS-700 Gamma Scan Data Analysis

The data collected during the gamma scan using the RS-700 system are evaluated as follows. A tiered approach is used during data review for the RS-700 system data to identify areas requiring additional surveys and biased samples as described in the second stage of the gamma count rate surveys. Ten ROIs have been established for radium and progeny as well as other naturally occurring or anthropogenic gamma-emitting radionuclides that may be of interest. Three virtual detectors (VDs) are set up in the analysis software (RadAssist). VD1 denotes both detectors summed, VD3 refers to the left detector, and VD4 refers to the right detector.

First, the data file is replayed in RadAssist and reviewed for elevated count rates in several relevant ROIs. Next, the count rates for several relevant ROIs are plotted in a time series and reviewed for additional peaks. The Z-scores are calculated for each location in all ROIs for VDs 1, 3, and 4. Local Z-scores are also calculated using a moving average to identify elevated count rates where the background is variable, for SUs that meet this criterion. Semi-local Z-scores are calculated using the global average but with a moving average for the standard deviation to identify smaller areas of elevated count rates that may not be otherwise identified by the initial Z-score review, for SUs that meet this criterion. Any location with four or more ROIs having a Z-Score, local Z-score, or semi-local Z-score, respectively, greater than 3 (Z>3) is marked for follow-up. These three types of Z-scores are also plotted in a time series and reviewed for additional peaks in Z-score. Finally, count rate ratios are calculated for key ROIs and reviewed for obvious peaks or outliers.

3.5.2 Instrument Detection Calculations

The equations to calculate efficiencies, MDCs, and minimum detectable count rates (MDCRs) at HPNS are based on the methodology and approach used in MARSSIM (Chapter 6) and Nuclear Regulatory Commission (NRC) Regulation (NUREG)-1507 (Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions [NRC, 1998]) (Chapter 6). The instrument equations in this section may be used to calculate adjustments if the changes are approved in writing by a Certified Health Physicist before initial use. The following calculations are examples intended to illustrate the calculation approach.

3.5.2.1 Gamma Surface Activity

Estimating the amount of radioactivity that can be confidently detected using field instruments is performed by adapting the methodology and approach used in MARSSIM (Section 6.7.2.1) and NUREG-1507 (NRC, 1998) (Section 6.8.2) for determining the gamma scan MDC for photon-emitting radionuclides.

The scan MDC (in pCi/g) for areas is based on the area of elevated activity, depth of contamination, and the radionuclide (energy and yield of gamma emissions). The computer code Microshield can be used to model expected exposure rates from the radioactive source at the detector probe NaI crystal and includes source-to-detector geometry. The geometry is used to calculate the total flow of photons incident upon the detector crystal, called the gamma fluence rate, ultimately corresponding to an exposure rate that is associated with a count rate in the instrument.

The amount of radiation the detector crystal is exposed to from the modeled source is used to determine the relationship between the detector's net count rate and the net exposure rate (counts per minute per microroentgen per hour [cpm/µR/hr]).

3.5.2.2 Gamma Scan Minimum Detectable Concentration

The minimum detectable number of net source counts in the scan interval is given by s_i, which can be arrived at by multiplying the square root of the number of background counts (in the scan interval) by the detectability value associated with the desired performance (as reflected in d'), as shown in **Equation 3-2** (Equation 6-8 of MARSSIM):

Equation 3-2

$$s_i = d'\sqrt{b_i}$$

Where:

d' = index of sensitivity (α and β errors [performance criteria])
b_i = number of background counts in scan time interval (count)
i = scan or observation interval (seconds)

For scanning at HPNS, the required rate of true positives will be 95 percent, and the false positives will be 5 percent. From Table 6.5 of MARSSIM, the value of *d'*, representing this performance goal, is 3.28. The MDCR, in cpm, is calculated by **Equation 3-3** (Equation 6-9 of MARSSIM):

Equation 3-3

$$MDCR = s_i \times (60/i)$$

Where:

s_i = minimum detectable number of net source counts in the scan interval
i = scan or observation interval (seconds)

Next, the MDCR is used to calculate the *Surveyor* MDCR by applying a surveyor efficiency factor shown in **Equation 3-4** (Page 6-45 of MARSSIM):

Equation 3-4

$$MDCR_{Surveyor} = \frac{MDCR}{\sqrt{p}}$$

Where:

MDCR = minimum detectable count rate
p = surveyor efficiency

After a surveyor efficiency is selected, the relationship between the $MDCR_{surveyor}$ and the radionuclide concentration in soil (in becquerels per kilogram or pCi/g) is determined. This correlation requires two steps: 1) establish the relationship between the detector's net count rate and net exposure rate (cpm/µR/hr), and 2) determine the relationship between the radionuclide contamination and exposure rate. The relationship between the detector's net count rate and the net exposure rate may be determined analytically, using reference guidance documents, or obtained from the detector manufacturer. Modeling (using Microshield) of the source area is used to determine the net exposure rate produced by a given concentration of radionuclides at a specific distance above the source. The scan MDC is calculated by **Equation 3-5** (Page 6-45 of MARSSIM):

Equation 3-5

$$Scan\ MDC = \left(\frac{MDCR_{surveyor}}{\epsilon_{inst}}\right) \times \left(\frac{Radionuclide\ Concentration[pCi/g]}{Exposure\ rate[\mu R/h]}\right)$$

Where:

$MDCR_{surveyor}$ = minimum detectable count rate surveyor
ε_{imst} = instrument efficiency (cpm/µR/hr)
Radionuclide Concentration = modeled source term concentration (pCi/g)
Exposure Rate = result of model (µR/hr)

3.5.2.3 Example Gamma Scan Minimum Detectable Concentrations

An example a priori scan MDC calculation is provided herein for ^{226}Ra using a Ludlum 2221 with a Model 44-20 (3-inch by 3-inch NaI) detector. This example assumes a background level of 18,000 cpm and 95 percent correct detections and 5 percent false positive rates resulting in a *d'* of 3.28. A scan rate of 0.5 meter per second (m/s) (19.7 inches per second) provides an observation interval of 2 seconds (based on a diameter of approximately 1 m for the modeled area of elevated activity). The $MDCR_{surveyor}$

was then calculated assuming a surveyor efficiency (ρ) of 1 (assumes automated data logging). The scan MDC is calculated as follows:

$$s_i = 3.28 * \sqrt{\frac{18{,}000 * 2sec}{60sec}} = 80\ counts$$

$$MDCR = 80 * \left(\frac{60\ sec}{2\ sec}\right) = 2{,}410\ cpm$$

$$MDCR_{surveyor} = \frac{2{,}410\ cpm}{\sqrt{1}} = 2{,}410\ cpm$$

The relationship between the detector's net count rate and the net exposure rate has been obtained from the detector manufacturer and is 2,300 cpm/µR/hr. The relationship between the radionuclide contamination and exposure rate has been determined by modeling (using Microshield) the source area to determine the net exposure rate produced by a given concentration of radionuclides at a specific distance above the source. The Microshield Version 11.20 model has a source activity of 1 pCi/g of ^{226}Ra, a circular area of elevated activity of 1 m^2, a contaminated zone depth of 15 centimeters (cm) (6 inches), and a soil density of 1.6 grams per cubic centimeter. The modeling code determined an exposure rate at the detector height (dose point) of 10 cm (4 inches) above the source to be 1.130 µR/hr. The scan MDC for this source geometry is calculated as follows:

$$Scan\ MDC = \left(\frac{2{,}410cpm}{2{,}300cpm/\mu R/h}\right) \times \left(\frac{1.0[pCi/g]}{1.130[\mu R/h]}\right) = 0.93\ pCi/g$$

Additional a priori determinations are provided in **Table 3-7**. The MicroShield model parameters are identical to those described in the previous example, using either ^{226}Ra with a concentration of 1 pCi/g, or ^{137}Cs with a concentration of 0.113 pCi/g. Note that the measurement geometry and parameters modeled are meant to illustrate an assumption for the calculation. Contamination, if present, may not exist in the same modeled configuration, and the modeled scan MDCs may not apply. As shown in **Table 3-7**, the calculated gamma scan sensitivity for ^{137}Cs is not expected to be sufficient to detect ^{137}Cs at or below the RG. Therefore, compliance with the Parcel G ROD RAO for ^{137}Cs will be based on the analytical data from soils sampling.

Table 3-7. A Priori Scan MDCs

NaI Detector	RG	Scan MDC
Ludlum 44-20, 3x3	^{226}Ra, 1.0 pCi/g	0.93 pCi/g
	^{137}Cs, 0.113 pCi/g	2.30 pCi/g
RS-700	^{226}Ra, 1.0 pCi/g	0.036 pCi/g
	^{137}Cs, 0.113 pCi/g	1.18 pCi/g
Soil sorting system	^{226}Ra, 1.0 pCi/g	To be determined
	^{137}Cs, 0.113 pCi/g	To be determined

3.5.3 Calibration

Portable survey instruments will be calibrated annually at a minimum, in accordance with American National Standards Institute (ANSI) N323a-1997 Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments (ANSI N323) (ANSI, 1997), or an applicable later version. Instruments will be removed from service on or before calibration due dates for recalibration. If

ANSI N323 does not provide a standard method, the calibration facility should comply with the manufacturer's recommended method.

3.5.4 Daily Performance Checks

Before use of the portable survey instruments, calibration verification, physical inspection, battery check, and source-response check will be performed in accordance with SOP RP-108, *Count Rate Instruments,* and SOP RP-109, *Dose Rate Instruments* (**Appendix D**), or equivalent. Portable survey instruments will have a current calibration label that will be verified daily prior to use of the instrument.

Physical inspection of the portable survey instrument will include the following:

- General physical condition of the instrument and detector before each use
- Knobs, buttons, cables, connectors
- Meter movements and displays
- Instrument cases
- Probe and probe windows
- Other physical properties that may affect the proper operation of the instrument or detector

Any portable survey instrument or detector having a questionable physical condition will not be used until problems have been corrected. A battery check will be performed to ensure that sufficient voltage is being supplied to the detector and instrument circuitry for proper operation. This check will be performed in accordance with the instrument's operations manual. The instrument will be exposed to the appropriate (alpha, beta, gamma) check source to verify that the instrument response is within the plus or minus 20 percent range determined during the initial response check. The calibration certificates and daily QA/QC records for each instrument used and the instrument setup test records will be provided in the project report.

If any portable survey instrument, or instrument and detector combination, having a questionable physical condition that cannot be corrected fails any of the operation checks stated in SOP RP-108, *Count Rate Instruments*, or SOP RP-109, *Dose Rate Instruments* (**Appendix D**), or has exceeded its annual calibration date without PRSO approval, the instrument will be put in an "out of service" condition. This is done by placing an "out of service" tag or equivalent on the instrument and securing the instrument or the instrument and detector combination in a separate area such that the instrument and instrument and detector combination cannot be issued for use. The PRSO and Radiological Control Technician (RCT) and their respective supervisors will be notified immediately when any survey instrumentation has been placed "out of service." Instruments tagged as "out of service" will not be returned to service until all deficiencies have been corrected. The results of the daily operation checks, previously discussed, will be documented.

3.6 Radiological Investigation Implementation

This section provides guidance on the implementation of radiological investigations for soil.

3.6.1 Premobilization Activities

Before initiating field investigations, several premobilization steps will be completed to ensure that the work can be conducted in a safe and efficient manner. The primary premobilization tasks include training of field personnel and procurement of support services.

A list of the various support services that are anticipated to be required are as follows:

- Radiological analytical laboratory services
- Drilling subcontractor
- Civil surveying subcontractor

- Utility location subcontractor
- Vegetation clearance subcontractor
- Transport (trucking) subcontractor
- Concrete coring subcontractor

3.6.1.1 Training Requirements

Any non-site-specific training required for field personnel will be performed before mobilization to the extent practical. Training requirements are outlined in **Section 6**.

Medical examinations, medical monitoring, and training will be conducted in accordance with the APP/SSHP and **Section 6** requirements.

In addition to health and safety-related training, other training may be required as necessary including but not limited to the following:

- Aerial Lift (for personnel working from aerial lifts)
- Fall Protection (for personnel working at heights greater than 5 feet)
- Equipment as required (e.g., fork lift, skid steer, loader, back hoe, excavator)

3.6.1.2 Permitting and Notification

Before initiation of field activities for the radiological investigation, the contractor will notify the Navy Remedial Project Manager (RPM), Resident Officer in Charge of Construction (ROICC), Radiological Affairs Support Office (RASO), and HPNS security as to the nature of the anticipated work. Any required permits to conduct the fieldwork will be obtained before mobilization.

The contractor will notify the California Department of Public Health at least 14 days before initiation of activities involving the Radioactive Material License.

3.6.1.3 Pre-construction Meeting

A pre-construction meeting will be held before mobilization of equipment and personnel. The purpose of the meeting will be to discuss project-specific topics, roles and responsibilities of project personnel, project schedule, health and safety concerns, and other topics that require discussions before field mobilization. Representatives of the following will attend the pre-construction meeting:

- Navy (RPM, RASO, ROICC, and others as applicable)
- Contractor (Project Manager, Site Construction Manager, Project QC Manager, PRSO, and Site Safety and Health Officer [SSHO])
- Subcontractors as appropriate

3.6.2 Mobilization Activities

Mobilization activities will include site preparation, movement of equipment and materials to the site, and orientation and training of field personnel.

At least 2 weeks before mobilization, the appropriate Navy personnel, including the Navy RPM and ROICC and Caretaker Site Office, will be notified regarding the planned schedule for mobilization and site remediation activities. Upon receipt of the appropriate records and authorizations, field personnel, temporary facilities, and required construction materials will be mobilized to the site.

The temporary facilities will include restrooms, hand-washing stations, and one or more secure storage (Conex) boxes for short- and long-term storage of materials, if needed.

The applicable activity hazard analysis (AHAs) forms will be reviewed prior to starting work.

All equipment mobilized to the site will undergo baseline radioactivity surveys in accordance with **Section 6**. Surveys will include directs scans, static measurements, and swipe samples. Equipment that fails baseline surveying will be removed from the site immediately.

3.6.2.1 Locating and Confirming Boundaries

The first step to begin the radiological investigations is locating and marking the boundaries of the former TUs and SUs. This will be accomplished by using best management practices (BMPs) to identify boundaries and depths of the former TUs and SUs based on the previous TtEC reports (e.g., survey reports, drawings, and sketches), field observations (such as GPS locations from geo-referencing, borings, and visual inspection), and durable cover as-built records. Once the boundaries are located, the areas will be marked with paint or pin flags.

3.6.2.2 Site Preparation

After boundary location and mark-outs are completed, the following steps will be implemented to prepare the site for investigation and facilitating access.

- A radiologically controlled area (RCA) will be established around work areas and delineated with temporary fencing or caution tape, or equivalent, and have the appropriate warning signage posted. Access control points will be established and maintained. Radiological screening of personnel, equipment, and materials will be required when exiting the RCA. The RCA will be posted consistent with the requirements of the Radiation Protection Plan and SOP RP-102, *Radiological Postings* (**Appendix D**). Routine surveys and inspections will be performed along the fence line, consisting of dose rate measurements and visual inspections. Surveys will be performed to ensure that there is no change in dose readings in accessible areas that could negatively affect the public or environment. Any breaches in the fence during site activities will be repaired.
- Stormwater, sediment, and erosion control measures will be implemented to prevent soil from entering and leaving the site as detailed in **Section 8**.
- Dust control methods and air monitoring will be implemented during intrusive activities as detailed in **Section 8**.
- An independent field survey to identify, locate, and mark potential underground utilities or subsurface obstructions will be performed by a third-party utility locator subcontractor following a review of existing utility drawings of the affected areas. The survey will be conducted over the known or suspect areas where underground utilities may exist using ground-penetrating radar or electromagnetic instrumentation. Underground Service Alert will be contacted at least 72 hours before initiating intrusive activities. The results of the geophysical survey will be compared to the available historical drawings and combined with Underground Service Alert markings (if any) to identify locations of underground utilities. Additionally, a visual survey of the area to validate the chosen location will also be conducted. Colored marking paint (or stakes or equivalent) will be used to mark identified utilities, if any, within the proposed work area. A minimum of 2 feet from the closest observed utility will be maintained to prevent accidental exposure to the utility, based on the utility hazard or importance. Utility lines encountered will be assumed active, unless specifically determined to be inactive through consultation with the subject utility company and with the Navy Caretaker Site Office representative, ROICC, and RPM.
- For both Phase 1 TUs and Phase 2 TUs, the asphalt cover will be removed to expose the target soils. Because of the inherent difficulty expected to determine the exact horizontal boundaries of the previous excavation, to provide access to the TU, and to account for regrading, an additional 1 foot of asphalt material on both sides of the historical trench excavation boundary will be removed to allow for a sufficient buffer for excavation of trench materials (Phase 1 TUs) and access for the surface gamma scan (Phase 2 TUs). After the asphalt cover is removed, attempts will be made to

confirm the delineation between fill materials and native soils by reviewing cut-and-fill drawings and visual inspections.

- Durable cover materials, listed above, will require release surveys prior to offsite disposal. Release surveys of the materials will be performed according to SOP RP-105, *Unrestricted Release Requirements* (**Appendix D**).

3.6.3 Phase 1 Trench Unit Investigation

Once all site preparation activities previously described are completed, TU investigation activities will commence.

Each former TU will be excavated to the original excavation limits and evaluated in approximately 152 m^3 ESUs. The excavated material will then undergo radiological assay following either the automated soil sorting process or RSY pad process as described in the following sections. One hundred percent of the Phase 1 ESU soils will undergo scan surveys using real-time gamma spectroscopy equipment in the soil sorting process or the RSY pad process. Details on the scanning instrumentation can be found in **Section 3.5**.

Once the excavation to the original excavation limits has been complete, over-excavation of at least an additional 6 inches outside the estimated previous boundaries of the sidewalls and bottom will be initiated. This exhumed over-excavated material (SFU) will be maintained separate from the backfill volumes (ESU) and will represent the trench sidewalls and bottom. The over-excavated material (SFUs) will be investigated in the same fashion as the excavated soil (ESU) methodology by gamma scan surveys and soil sample collection (soil sorting system process or RSY process). Following completion of scanning activities, the ESU and SFU material will either be returned to the same trench that the material originated from or will be segregated for further investigation.

3.6.3.1 Automated Soil Sorting System Process

Excavated TU materials will be transported to a soil sorting area for processing. Processing activities using automated soil sorting technology include gamma surveys using large-volume gamma spectroscopy detectors to monitor multiple isotopes simultaneously (including ^{226}Ra and ^{137}Cs) and to provide real-time NORM background subtraction, systematic and biased sampling and analyses, performing investigation activities (as necessary), radiologically –clearing the materials for either reuse or disposal and transport of the materials out of the soil sorting area.

Because soil sorting systems are designed to be deployed on a flexible and scalable platform, the system will be tailored to achieve the project-specific requirements and objectives. The configuration details, including detectors, MDCs, and specific operating set points, will be provided under separate cover in a Soil Sorting Operations Plan. The Soil Sorting Operations Plan will be submitted to the regulatory agencies for review and concurrence. The remainder of this section generally describes the soil sorting process and the minimum requirements of the soil sorting technology.

Transfer of Excavated Soil for Processing

Excavated TU materials will be transported to the soil sorting area by dump truck or other conventional means. Excavated soil entering the soil sorting area must be accompanied by a truck ticket (paper or digital) to facilitate transfer of the material for radiological processing. This ticket will provide the soil sorting staff with the following information:

- Location of excavation, including former TU name
- From which TU sidewall or floor surface material was excavated (if applicable)
- Load number
- Estimated volume of soil
- Date and time of excavation

The material will be collected into individual 152 m^3 batches as described herein. The soil sorting personnel will tell the driver where to place the material for subsequent processing through the soil sorting system.

General Process

Soil sorting systems are radiological monitoring and processing systems designed to perform real-time segregation of soil into two distinct bins based upon its radiological properties. The system is capable of processing and segregating large volumes of soil with relatively high throughput rates. Commercially available material conveyors are used to physically manage the soil. These conveyors prepare and condition material, they transport the material past the monitoring devices (various radiation sensors), and they provide the physical means to sort material.

The material is sorted into two distinct bins (piles), commonly referred to as the “Below Criteria” and “Diverted Pile” bins. The basis upon which the soil material is sorted and segregated into distinct volumes is controlled by the establishment of “diversion control setpoints” that automatically trigger the diverting mechanism, sorting the material into the appropriate bin. The selection of the system’s diversion control setpoints depends on a number of factors and will ultimately be chosen and described in the Soil Sorting Operations Plan. At a minimum, diversion control setpoints will sort soil at the ILs listed in **Section 3.3.1** and will and divert radiological commodities such as deck markers if encountered. Soil diverted to the “Diverted Pile” bin will be investigated as a potential area of elevated activity (**Section 5.3.2**).

Soil stockpiles (ESUs or SFUs) consisting of either former TU fill material or trench sidewalls and bottom materials with a maximum size of 152 m^3 will be staged near the soil sorting system. Using typical earth moving equipment such as a front-end loader or excavator, soil will be fed to the soil sorting system. If necessary, the material may be processed through a trommel to condition the soil to flow through the conveyor-based system. Once the soil reaches the primary assay conveyor, the material will pass under a fixed strike-off plate (or equivalent) to ensure that the thickness of the material does not exceed 6 inches. The material will move past the active area of the detectors, and the system’s software will interpret the spectroscopy data to determine whether the volume of soil exceeds the specified alarm points. As the material continues to travel up the conveyor, it is automatically sorted in one of two bins. The typical soil sorting layout is shown on **Figure 3-5**.

Although the specific configuration details will be detailed separately in the Soil Sorting Operations Plan, the soil sorting system will maintain compliance with the following established soil gamma scanning requirements:

- Survey belt will not exceed 0.5 m/s
- System will be equipped with at least 1 large-volume gamma detector (e.g., 4-inch x 4-inch x 16-inch NaI)
- Soil thickness on the belt will be a maximum of 6 inches

Following completion of an ESU or SFU batch, the radiological results will be generated using soil sorting reporting software. Reports will include the basic statistical metrics for each of the two bins of soil that were created including the mean, median, min, max, and standard deviation of the gamma-emitting ROCs.

Soil Sampling and Follow-up Activities

The ultimate compliance with the Parcel G ROD RAO is demonstrated by collecting and analyzing soil samples for the applicable ROCs. Eighteen systematic soil samples (as determined in **Section 3.4.1**) will be collected from each ESU and SFU during assay with the soil sorting system. In the case of soil sorting, systematic samples will be collected at a given time period, the frequency of which is determined to provide a systematic distribution of sample collection throughout each ESU or SFU. For example, if the soil sorting system is configured to process a 152 m^3 batch in 3 hours, a systematic sample will be collected every 10 minutes (180 minutes/18 samples = 10 minutes). Systematic samples will be collected by compositing material within each 10-minute interval. Samples will be collected from material moving through the soil sorter before discharge.

If soil material has been discharged to the "Diverted Pile," an investigation of the potential area of elevated activity (i.e., the Diverted Pile material) will be conducted. At a minimum, the soil sorting reporting software results will be reviewed to identify the causes for diverting material, and biased soil samples will be collected. The biased soil samples will be collected from the soil material that has been discharged to the Diverted Pile bin at a frequency equal to the volumetric frequency of sampling for ESU or SFU material. Using the current minimum number of systematic samples in a given unit (18), with a maximum unit size of 152 m^3, a sample will be collected roughly every 8.5 m^3, with a minimum of at least one sample being collected if the volume is less than 8.5 m^3. Additionally, if the soil material discharged to the Diverted Pile originates from an SFU and is confirmed to contain contamination, an in situ investigation of the open trench will be performed at the excavation location of the soil. Material discharged to the Diverted Pile will remain segregated until completion of the investigation activities. The trench under investigation will remain open until investigation and remediation activities are completed. If necessary, additional samples may be collected from diverted material to support characterization for waste disposal.

The SFU in situ investigation will include the performance of a gamma scan over the trench surface requiring investigation and additional biased and systematic sampling. The trench investigation gamma count rate survey will be performed in two stages. The first stage is a gamma count rate scan conducted over 100 percent of the accessible area using the Ludlum Model 44-20 and Ludlum Model 2221 (or equivalent) handheld instrument, consistent with the requirements for a MARSSIM survey (USEPA et al., 2000). The data collected during the gamma scan are evaluated, and if all readings are below the instrument-specific gamma scan IL or otherwise do not indicate the presence of an anomaly (e.g., via Z-score analysis, spatial plots, or other statistical analysis), the second stage is not required, and systematic samples will be collected as described in **Section 3.4.2**.

If the count rate exceeds the instrument-specific gamma scan IL or indicates that further investigation is warranted, the second stage commences (additional survey and possible soil sampling at the location and adjacent area where the count rate exceeded the scan instrument-specific scan IL and nearby areas). The second stage will consist of reacquiring the location of the elevated gamma count rate and conducting a 1-minute gamma static count using a Ludlum Model 44-20 and Ludlum Model 2221, or equivalent, handheld instrument. The nearby area will be resurveyed to assess whether the elevated gamma scan reading is the result of a point source or distributed radioactive material. If the gamma static (1-minute) count is less than the instrument-specific static IL, and there is no evidence of a point source, further survey investigation is not required, and systematic samples will be collected.

Surface soil samples will be collected on a systematic sampling grid and/or from biased locations identified by the gamma static survey. A minimum of 18 systematic soil samples (as determined in **Section 3.4.1**) will be collected from each SU as described in **Section 3.4.2**.

Each 1,000 m^2 trench SFU will be plotted using VSP software (or equivalent) to determine the location of the 18 systematic soil samples. The systematic soil samples will be plotted using a random start triangular or square grid with VSP software. Soil samples will be collected from the trench surface at a depth of 0 to 6 inches. The technique for locating systematic samples is provided in **Section 3.4.2**. Soil samples will be containerized and submitted to an offsite laboratory with appropriate chain-of-custody documentation as established in the SAP (**Appendix B**).

Soil processed by the soil sorter system and subsequently staged for offsite disposition or onsite reuse will be staged pending evaluation of offsite analytical results and Navy approval for disposition or reuse.

Soil pending offsite analytical results may be staged in stockpiles smaller than 152 m^3 , which would permit the re-evaluation of smaller soil volumes should elevated soil sample results be received from the offsite laboratory.

If elevated sample results are identified by offsite analysis, the contractor will notify the Navy and determine a suitable soil rescreening process, either by RSY pad or by the soil sorter. SFU sampling locations with results that exceed RGs and background will be remediated by additional soil excavation.

Mobilization, Setup, and Calibration

Mobilization and setup of the system typically requires up to 2 weeks. The system will be setup and configured at a suitable location with respect to accessibility, while not impacting load paths for heavy excavation equipment. Depending on the configuration of the material handling components, conveyors typically arrive on flatbed tractor trailers and require offloading into their designated position. Assembling the conveyors and other physical structures typically takes 1 to 2 days. Assembling and testing of all the measurement equipment and sensors, data cables, computers and mobile command center typically takes an additional 2 days. Additionally, it usually takes 3 days for configuring and calibrating the system. Before setup, the area where the system will be operated will be radiologically scan-surveyed to document the existing conditions.

Several dust management practices can be used during soil sorting operations to minimize potential dust. Practices include adding wind panels to shield against winds that may create dust from the initial loading process, equipping discharge chutes with shrouds, in-line misting systems, dust mist oscillation cannons, and sorting under an enclosure. The usage of an enclosure, if deemed appropriate, would require a tent approximately 25 feet by 50 feet. The final dust management practices will be finalized before mobilization of the system and may be modified during operations as necessary.

Quality Assurance and Quality Control

The automated soil sorting system will adhere to strict QA/QC measures, to ensure accurate assay of the soil. The specific performance and documentation of the QA/QC measures will be included in the Soil Sorting Operations Plan; however, at a minimum, the following QA/QC tests will be interwoven with routine material processing operations:

- Spectral alignments
- Belt speed test
- Mass (weight) scale test
- Ambient background response
- Independent testing and confirmation

3.6.3.2 Radiological Screening Yard Pad Process

If a conveyor-based automatic soil sorting system process is not selected, excavated TU material will be assayed using the previously applied RSY process. Excavated TU materials will be transported to an RSY pad and spread approximately 6 to 9 inches thick for processing. Processing activities in the RSY pads include gamma scan surveys, using a large-volume gamma scintillator equipped with spectroscopy, systematic and biased sampling and analyses, performing investigation activities (as necessary), radiologically clearing the materials for either reuse or disposal, and transport of the materials off the RSY pads. The objective of the processing activities on the RSY pads is to characterize the material. Material that meets the RGs identified in **Table 3-5** will be used as backfill material or shipped offsite as non-LLRW. Before initiating excavation activities at each TU, existing RSY pads will be identified for use or new pads will be constructed. Transport routes between the TU and the selected RSY pads will be established and approved by the Navy before initiating excavation activities at each TU.

Construction of Radiological Screening Yard Pads

If no existing RSY pads are available for use, pads will be constructed to meet the requirements specified in the Basewide Radiological Management Plan (TtEC, 2012) and the RSY Construction Details (TtEC, 2009b). RSY pads will be constructed with a size limit of 1,000 m^2. Before construction, the area where the RSY pads will be constructed will be radiological scan-surveyed to document the existing conditions.

Transfer of Excavated Soil for Processing

Excavated TU materials will be transported to the RSY pad by dump truck or other conventional means. Excavated soil entering an RSY must be accompanied by a truck ticket (paper or digital), to facilitate transfer of the material for radiological processing along a designated truck route. This ticket will provide the RSY staff with the following information:

- Location of excavation, including former TU name
- From which TU sidewall or floor surface material was excavated (if applicable)
- Load number
- Estimated volume of soil
- Date and time of excavation

The RSY personnel will direct the driver to the appropriate RSY pad for soil placement. The truck ticket will be amended with the assigned unique RSY pad number for tracking purposes. Placement of soil on a RSY pad in the RSYs will continue until the soil placed on the RSY pad reaches capacity as identified by the RSY Manager (or designee) and is ready for processing.

Each individual 152 m^3 TU stockpile will be loaded into the RSY pad, spread out, and leveled to a maximum depth of 6 inches for investigation.

General Process

The RSY process will include gamma scans over 100 percent of the surface area, systematic, and biased soil sampling. A minimum of 18 systematic soil samples (as determined in **Section 3.4.1**) will be collected from each pad along with any biased samples based on the results of the gamma scan surveys.

Gamma scans of the spread soil will be performed using a GPS coupled to an appropriate gamma scintillation scanning system, examples of which are provided in **Section 3.5**. The RS-700 gamma detection system will be used as the primary gamma scanning instrument.

Using the RS-700 system (or equivalent), the scans will be performed by scanning straight lines at a not-to-exceed rate of 0.25 m/s with a consistent detector distance from the soil surface (approximately 4 inches above the surface). Generally, RSY pad lift will be gamma scanned as follows (the following description assumes the RSY area is positioned such that the sides align with north, south, east, west directions):

- Begin with the detector positioned in the southwest corner of the RSY pad at a height of approximately 4 inches above the surface. Orient the system to face north and initiate data collection (detector is automatically logging radiation readings and GPS is automatically logging position readings) so that the system is recording at a rate of one reading per second (or other, as determined by the project Health Physicist).
- Move the detector in the north direction at a not-to-exceed speed of 0.25 m/s.
- Once the detector has reached the edge of the pad, turn the system around (now facing south) and offset the next detector path by the appropriate offset based on the instrument’s detector size (e.g., field of view), to allow for a small overlap in the detector field of view.
- Move the detector in the southern direction at a not-to-exceed speed of 0.25 m/s.

- Repeat these steps until the soil on the RSY pad area has been scan-surveyed.

The data collected during the gamma scan using the RS-700 are evaluated as described in **Section 3.5.1.1**. If gamma scan surveys indicate areas of potentially elevated activity in soil above the ILs (**Section 3.3.1**), an investigation of the potential area of elevated activity will be initiated. At a minimum, the contractor will further evaluate the gamma scan data and collect biased soil samples. A biased soil sample will be collected from the approximate location of the highest elevated gamma scan survey measurement. If areas displaying elevated activity are collocated, an attempt will be made to locate the area with the highest gamma scan results and designate it as the biased sample location to represent the collocated elevated areas. Material with potentially elevated concentrations will remain segregated until completion of the investigation activities. Additionally, if soil sampling indicates areas of potentially elevated soil above the RGs and it is confirmed that the soil contains contamination, and if the soil material originates from an SFU, an in situ investigation of the open trench will be performed at the excavation location of the soil, as described in **Section 3.6.3.1**.

Each 1,000 m^2 RSY pad area will be plotted using VSP software (or equivalent) to determine the location of the 18 systematic soil samples. The systematic soil samples will be plotted using a random start triangular or square grid using the VSP software. Soil samples will be collected from the surface at a depth of 0 to 6 inches. The technique for locating systematic samples is provided in **Section 3.4.2**. Soil samples will be containerized and submitted to offsite laboratory with appropriate chain-of-custody documentation as established in the SAP (**Appendix B**).

Soil processed by the RSY process and subsequently staged for offsite disposition or onsite reuse will be staged pending evaluation of offsite analytical results and Navy approval for disposition or reuse. If elevated sample results are identified by offsite analysis, the contractor will notify the Navy and determine a suitable soil rescreening process, either by RSY pad or by the soil sorter. SFU sampling locations with results that exceed RGs and background will be remediated by additional soil excavation.

Following completion of scan surveys, sampling, and any potential investigation activities, the excavated material will be returned to the same trench that the material originated from.

3.6.4 Phase 2 Trench Unit Investigation

Investigations of the Phase 2 TUs will consist of a combination of gamma scan surveys and soil samples.

Gamma scan surveys of the surface soil will be performed using one or a combination of the gamma detectors listed in **Table 3-6** (or equivalent). The scan surveys will generally be performed using the same protocols and methods as those in the RSY pads. Of the accessible surface of the Phase 2 TUs, 100 percent will be gamma scan-surveyed using a GPS coupled to a large-volume gamma scintillator, equipped with real-time gamma spectroscopy and data logging.

Data sets will be transferred from the data logger onto a personal computer to create spreadsheets and to map the gamma scan survey results. Data obtained during the surface gamma scan surveys, including gross gamma and individual radionuclide spectral measurements, will be analyzed to identify areas where surface radiation levels appear to be greater than the radionuclide-specific ILs using ROI-peak identification tools.

If gamma scan surveys indicate areas of potentially elevated activity in soil above the ILs (**Section 3.3.1**), an investigation of the potential area of elevated activity will be initiated. At a minimum, the contractor will further evaluate the gamma scan data and collect biased soil samples. The biased soil sample will be collected from the approximate location of the highest elevated gamma scan survey measurement. If areas displaying elevated activity are collocated, an attempt will be made to locate the area with the highest gamma scan results and designate it as the biased sample location to represent the collocated elevated areas.

The systematic boring locations will be cored down to approximately 6 inches below the depth of previous excavation within each TU boundary. Soil samples will be collected as described in **Section 3.6.4.1**. Sanitary sewer and storm drain lines were sometimes installed on bedrock. In these situations, sampling of bedrock will not be performed. If refusal is encountered within 6 inches of the expected depth of the trench, the soil sample will be collected from the deepest section of the core. If refusal is encountered more than 6 inches above the expected depth of the trench, the sample location will be moved to avoid the subsurface obstruction.

To acquire three samples from each boring, one surface and one floor sample will be collected from each sample core. The sample cores will be scanned for gamma radiation along the entire length of each core using a Ludlum Model 44-20 3-inch by 3-inch NaI (or equivalent) equipped with gamma spectroscopy. Scan measurement results will be evaluated against the IL to identify core section with elevated gamma radiation. Core sections that exceed the IL will have biased soil samples collected to investigate the potential for small areas of elevated activity in fill. If no core section exceeds the IL, a biased sample will be collected from the core segment with the highest gamma scan reading that was not already sampled, for a total of at least three samples from each core.

Additionally, systematic samples will be collected from sidewall locations every 50 linear feet, representative of each of the trench sidewalls. The boring locations will be located within 1 meter of the previous sidewall excavation limits and will extend to the maximum previous excavation depth. In the same action described in the previous paragraph, core sections will be retrieved, scanned, and sampled such that at least three samples will be collected from each of the six boring locations. An example graphic showing the sample locations representing the TU sidewalls is provided on **Figure 3-4**.

If GPS reception is available, soil sample locations will be position-correlated with GPS data and recorded. If GPS reception is not available, a reference coordinate system will be established to document gamma scan measurement results and soil sample locations. The reference coordinate system will consist of a grid of intersecting lines referenced to a fixed site location or benchmark. If practical, the GPS coordinates of the fixed location or benchmark will be recorded.

Remediation of soil with analytical results above the RGs and background will be performed by excavation of the identified location of the elevated activity or by excavation of the complete TU (for Phase 2 TUs) for further processing using the RSY pad or soil sorting processes. Following excavation, a minimum of five bounding confirmation samples will be collected at the lateral and vertical extents to confirm the removal of contaminated soil. If a Phase 2 TU is excavated in its entirety, it will be investigated following the process described for a Phase 1 TU in **Section 3.6.3**. Material with potentially elevated activity will remain segregated until completion of the investigation activities.

3.6.4.1 Subsurface Soil Sample Collection

Subsurface soil samples will be collected by following the *Soil Sampling* SOP, included in **Appendix D**. Subsurface soil samples will be collected using drilling-rig-mounted equipment to collect samples with thin-walled tube sampling or split-spoon sampling. When needed, other methods may be considered and applied. Specific sampling methods used will be documented in the field, and deviations from the work plan will be described in the final report. Disposable sampling equipment will be used whenever practical and will be disposed of immediately after use. If reusable sampling equipment is used, decontamination between sampling locations will be performed following the *Decontamination of Personnel and Equipment* SOP, included in **Appendix D**. Generally, drilling and retrieving the boring using the thin-walled tube method will be as follows:

- Using a drilling rig, a hole is advanced to the desired depth. The samples are then collected following the ASTM International (ASTM) D 1587 standard.
- The sampler is lowered into the hole so that the sample tube's bottom rests on the bottom of the hole. The sampler is advanced by a continuous, relatively rapid downward motion. The sampler is

withdrawn from the soil formation as carefully as possible to minimize disturbance of the sample. To obtain enough volume of sample for subsequent laboratory analysis, use of a 3-inch-internal-diameter sampler may be required.

- Upon removal of the tube from the ground, drill cuttings in the upper end of the tube are removed, and the upper and lower ends of the tube are sealed. The soil tube will be turned over to the project geologist and radiation technician for sample preparation, radiological surveys, and containerization. Once retrieved from the hole, the tube is carefully cut open to maintain the material in the tube.

Generally, drilling and retrieving the boring using the split-spoon sampling method will be performed as follows:

- Using a drilling rig, a hole is advanced to the desired depth. The samples are then collected following the ASTM D 1586 standard.
- The sampler is lowered into the hole and driven to a depth equal to the total length of the sampler; typically, this is 24 inches. The sampler is driven down using a weight (“hammer”). To obtain enough volume of sample for subsequent laboratory analysis, use of a 3-inch-internal-diameter sampler may be required.
- Upon removal of the soil core from the ground, the soil core will be turned over to the project geologist and radiation technician for sample preparation, radiological surveys, and containerization. Once retrieved from the hole, the sampler is carefully split open to maintain the material in the tube.

Once the soil tube has been cut open or the core has been split open, soil examination and sample collection will occur as follows:

- The geologist log will log the soil boring to provide accurate and consistent descriptions of soil characteristics. Soil boring logs will be maintained according to the *Logging of Soil Borings* SOP, included in **Appendix D**.
- The sample for radiological analyses will be mixed in the field by breaking the sample into small pieces and removing gravel. The depth, recovery position, and scan measurement information should be correlated to each sample extracted from the core.
- A minimum of 200 grams of soil (approximately 1 cup) are required to complete all required analyses, or 400 grams if the sample is selected as a field duplicate. If sample size requirements are not met by a single sample collection, additional sample volume may be obtained by collecting a sample from below the original sample location within the core and compositing the sample.
- The entire mixed sample will be placed in the designated laboratory sample container and the range of soil depths included in the sample recorded in the field logbook.
- Samples will be identified, labeled, and cataloged according to the SAP (**Appendix B**) and **Section 3.6.6**, and then placed into the appropriate sample cooler (if required) for transport to the laboratory. Custody of the sample will be maintained according to the *Chain-of-Custody* SOP, included in **Appendix D**.
- When a field duplicate sample is required (1 for every 10 field samples collected), the sample will be evenly split following mixing of the material and removal of extraneous material, and each aliquot placed into an appropriately labeled sample container.
- If insufficient soil for sampling is obtained from the original borehole, an adjacent location will be considered.

3.6.5 Former Building Site and Crawl Space Soil Survey Unit Investigation

Surface soil SUs will be characterized in a similar fashion as the RSY process described in **Section 3.6.3**, using a combination of surface soil gamma scan surveys and systematic and biased soil sampling.

Gamma scan surveys will be performed using one or a combination of the gamma detectors listed in **Table 3-6**. The scan surveys will be performed using the same protocols and methods as those in the RSY pads. One hundred percent of the accessible surface of the Phase 1 SUs will be gamma scan-surveyed using a large volume gamma scintillator, equipped with real-time gamma spectroscopy and data logging.

If GPS reception is available, gamma scan surveys will be position-correlated with GPS data. If GPS reception is not available, which is likely for SUs located within the Building 351A Crawl Space, a reference coordinate system will be established to document gamma scan measurement locations. The reference coordinate system will consist of a grid of intersecting lines referenced to a fixed site location or benchmark. If practical, the GPS coordinates of the fixed location or benchmark will be recorded.

Data sets will be transferred from the data logger onto a personal computer to create spreadsheets and, if feasible, gamma scan survey results will be mapped. Data obtained during the surface gamma scan surveys, including gross gamma, and individual radionuclide spectral measurements, will be analyzed to identify areas where surface radiation levels appear to be greater than the radionuclide-specific ILs using ROI-peak identification tools.

The data collected during the gamma scan using the RS-700 are evaluated as described in **Section 3.5.1.1**.

If gamma scan surveys indicate areas of potentially elevated activity in soil above the ILs (**Section 3.3.1**), an investigation of the potential area of elevated activity will be initiated. At a minimum, the gamma scan data and collection of biased soil samples will be conducted. The biased soil sample will be collected from the approximate location of the highest elevated gamma scan survey measurement. If areas displaying elevated activity are collocated, an attempt will be made to locate the area with the highest gamma scan results and designate it as the biased sample location to represent the collocated elevated areas. Potentially elevated material will remain segregated until completion of the investigation activities.

Areas known or suspected of containing radioactive materials will be isolated pending removal of the material. Discrete radioactive objects (or highly concentrated and localized soil contamination) will be identified during gamma count rate scan surveys. Measurements exceeding instrument-specific ILs will be delineated to the extent possible based on gamma surveys prior to removal.

If the anomaly is confirmed to be radioactive material, it will be removed. Removal actions will involve evaluating the area around the coordinates of the suspected radioactive material. A minimum of 1 foot in each direction of the surrounding soil will be removed and designated as LLRW.

After the radioactive material and surrounding soil are excavated, the resulting excavation will be resurveyed by gamma scan. If elevated gamma emitters persist, further gamma surveys of the soil will be performed until the source of the elevated gamma activity is found and removed. Four or more post-excavation bounding samples will be collected from the soil at the edge of the bounding excavation and beneath the discrete source (e.g., radium object), if present, to verify that the contamination was removed.

If the source of elevated radioactivity above the RGs and background cannot be readily identified as a point source, the limits of the anomaly will be identified, and the excavated material will be segregated for disposal. Sampling locations with results that exceed RGs and background will be remediated by soil excavation of the SU.

The location of the 18 systematic soil samples will be determined using VSP software, or equivalent, and located using GPS if available, or the established reference coordinate system used during the gamma scan survey. The systematic and biased soil samples collected from each SU will be collected based on the process described in **Section 3.6.5.1** and submitted to the offsite analytical laboratory for analysis according to the SAP (**Appendix B**).

3.6.5.1 Surface Soil Sample Collection

Prior to surface soil sampling, the necessary gamma scan measurements will be collected as described above. Surface soil samples will be collected in accordance with the *Soil Sampling* SOP, included in **Appendix D**. Disposable sampling equipment will be used whenever practical and will be disposed of immediately after use. If reusable sampling equipment is used, decontamination between sampling locations will be performed following the *Decontamination of Personnel and Equipment* SOP, included in **Appendix D**. Generally, the surface soil sample will be collected as follows:

- A clean shovel, hand auger, or other tool will be used to remove a small area (about 3 inches in diameter) of soil to a depth of 6 inches.
- The removed soil will be transferred directly into a clean stainless-steel bowl for mixing.
- The soils removed from the sample location will be visually described in the field logbook in accordance with the *Preparing Field Log Books* SOP, included in **Appendix D**. Color, moisture, texture, and clast composition (i.e., serpentine, shale, sandstone, chert, gabbro) will be identified.
- The sample for radiological analyses will be mixed in the field by breaking the sample into small pieces, removing overburden gravel and biological material. The entire mixed sample, or aliquot thereof, will be placed in the designated laboratory sample container.
- When a field duplicate sample is required (1 for every 10 field samples collected), the duplicate sample will be collected following mixing of the material and splitting the aliquot into an additional sample container.
- Samples will be identified, labeled, and cataloged according to the SAP (**Appendix B**) and **Section 3.6.6**, and then placed into the appropriate sample cooler (if required) for transport to the contract laboratory. Custody of the sample will be maintained according to *Chain-of-Custody* SOP, included in **Appendix D**.
- A minimum of 200 grams of soil (approximately 1 cup) are required to complete all required analyses, or 400 grams if the sample is selected as a field duplicate.

3.6.6 Sample Identification

Each soil sample will be uniquely identified at the time of collection as described herein.

3.6.6.1 Phase 1 Trench Unit Samples

Sample identifications (IDs) from the Phase 1 soil trench unit investigation will be identified using the following format:

AABB-CCC-NNNA-DDD

Where: AA = facility (HP for Hunters Point will be used in this work plan)

BB = site location (PG for Parcel G will be used in this work plan)

CCC = excavation soil unit or sidewall floor unit

NNN = former trench unit number

A = alpha-numeric digit of each “batch” (beginning with A, in sequential order)

DDD = numeric sample digit (beginning with 001, in sequential order)

For example, the first soil sample collected from the third “batch” of backfill TU material excavated from the former TU 69 will be identified as follows:

HPPG-ESU-069C-001

In this example, “HPPG” identifies Hunters Point Parcel G, “ESU” identifies excavation soil unit, “069” identifies the unit as being excavated from the former Trench Unit 69, “C” represents the third unit or “batch” created from excavating this former TU, and “001” identifies the first sample.

3.6.6.2 Phase 2 Trench Unit Samples

Sample IDs from the Phase 2 soil trench unit investigation will be identified using the following format:

AABB-CCC-NNN-EEFF-GG-DDD

Where: AA = facility (HP for Hunters Point will be used in this work plan)

BB = site location (PG for Parcel G will be used in this work plan)

CCC = excavation soil unit (ESU) or sidewall floor unit (SFU)

NNN = former trench unit number

EEFF = two-digit sample interval in feet bgs (EE feet = top of sample interval and FF feet = bottom of sample interval). EE and FF are whole numbers such that a value of “01” represents “1 foot bgs.” Surface samples (samples collected from the 0.0- to 0.5-foot depth interval) will be designated as 000H; H is for half foot. If the surface sample is collected from a depth other than a half foot, the H designation will still be used; however, a note will be included in the field book to indicate the actual depth sampled.

GG = soil boring number within the TU

DDD = numeric sample digit (beginning with 001, in sequential order)

For example, the first soil sample collected from the surface of sidewall TU material from the former TU 66 will be identified as follows:

HPPG-SFU-066-000H-01-001

In this example, “HPPG” identifies Hunters Point Parcel G, “SFU” identifies sidewall floor unit, “066” identifies the unit as being excavated from the former Trench Unit 66, “000H” represents the depth interval for a surface sample (000H is the agreed-upon code established for surface samples as explained above), “01” identifies soil boring number 01, and “001” identifies the first sample.

3.6.6.3 Former Building Site and Crawl Space Soil Survey Unit Samples

Sample IDs from the soil SU investigation will be identified using the following format:

AABB-CCCC-SUNN-DDD

Where: AA = facility (HP for Hunters Point will be used in this work plan)

BB = site location (PG for Parcel G will be used in this work plan)

CCCC = building site name

SUNN = survey unit number

DDD = numeric sample digit (beginning with 001, in sequential order)

For example, the second soil sample collected from the Building 351A Crawl Space in Survey Unit D will be identified as follows:

HPPG-351A-SUD-002

In this example, “HPPG” identifies Hunters Point Parcel G, “351A” identifies the Building 351A Crawl Space, “SUD” identifies the unit as being Survey Unit D, and “002” identifies the second sample.

3.6.7 Site Restoration and Demobilization

The open excavations will be backfilled with the excavated soil upon concurrence from RASO. The excavated material will be returned to the same trench that the material originated from. If additional backfill is required, a clean import source will be identified and used. Imported fill will be sampled and analyzed in accordance with the Basewide Radiological Management Plan (TtEC, 2012) and will be approved by the RASO before use. If the trench excavations are water logged, crushed rock or gravel will be placed as bridging material. With Navy concurrence, radiologically cleared recycled fill materials (e.g., crushed asphalt) may be used for backfill. The backfill will be compacted to 90 percent relative density by test method ASTM D1557. Once the excavated areas have been backfilled, the durable cover will be repaired “in kind” to match pre-excavation action conditions.

3.6.7.1 Deconstruction of Radiological Screening Yard Pads

Following completion of radiological screening and with Navy approval, the RSY pads will be deconstructed. Before deconstruction, the RSY pads will be radiologically screened and released in accordance with **Section 6**. The area will be down-posted for the deconstruction activities. The RSY pad material will be consolidated onsite for offsite disposal at an approved disposal facility. If the RSY pad buffer material cannot be reused onsite, it will be disposed of offsite at an approved disposal facility (**Section 7**). Following deconstruction, the area will be restored to pre-removal action conditions.

3.6.7.2 Decontamination and Release of Equipment and Tools

Decontamination of materials and equipment will be conducted at the completion of fieldwork. Numerous decontamination methods are available for use. If practical, manual decontamination methods should be used. Abrasive methods may be necessary if areas of fixed contamination are identified. Chemical decontamination can also be accomplished by using detergents for nonporous surfaces with contamination present. Chemicals should be selected for decontamination that will minimize the creation of mixed waste. Decontamination activities will be conducted using SOP RP-132, *Radiological Protective Clothing Selection, Monitoring, and Decontamination* (**Appendix D**).

3.6.8 Demobilization

Demobilization will consist of surveying, decontaminating, and removing equipment and materials, cleaning the project site, inspecting the site, and removing temporary facilities. Survey of equipment and materials will be performed in accordance with **Section 6.6**, and decontamination will be performed in accordance with **Section 3.6.7.2**. Demobilization activities will also involve collection and disposal of contaminated materials, including decontamination water and disposable equipment for which decontamination is inappropriate (**Section 7**).

3.7 Radiological Laboratory Analysis

Samples will be containerized and submitted to offsite laboratory with appropriate chain-of-custody documentation as established in the SAP (**Appendix B**). All laboratory analyses will be performed by a Department of Defense Environmental Laboratory Accreditation Program or National Voluntary Laboratory Accreditation Program-accredited laboratory certified by the State of California to perform analyses. All soil samples will be retained for possible California Department of Public Health confirmatory analysis until the final RACR for Parcel G is issued.

Analysis will be based on the site-specific ROCs listed in **Table 3-4**, and in accordance with the SAP (**Appendix B**) and as follows:

- Soil samples will be assayed using gamma spectroscopy analysis for ^{137}Cs and ^{226}Ra. Gamma spectroscopy data will be reported for all gamma-emitting ROCs by the laboratory after a full 21-day ingrowth period.
  - If the gamma spectroscopy laboratory results indicate a concentration of ^{226}Ra above the RG in a sample, the sample will be analyzed using alpha spectroscopy for uranium isotopes (^{238}U, ^{235}U, and ^{234}U), thorium isotopes (^{232}Th, ^{230}Th, and ^{228}Th), and ^{226}Ra to evaluate equilibrium conditions. Additional details regarding the equilibrium evaluation are provided in **Section 5.6**. All detected isotopes will be reported.
  - If laboratory results indicate a concentration of ^{137}Cs above the RG in a sample, the sample will be analyzed by gas flow proportional counting for ^{90}Sr and by alpha spectroscopy for ^{239}Pu.
- At least 10 percent of randomly selected samples will be analyzed by gas flow proportional counting for ^{90}Sr.
  - If laboratory results indicate a concentration of ^{90}Sr above the RG in a sample, the sample will be analyzed via alpha spectroscopy for ^{239}Pu.
- At the Former Buildings 317/364/365 Site and adjacent TUs 95, 117, 118, and 153 (**Figure 3-1**), where ^{239}Pu and ^{235}U are ROCs, at least 10 percent of randomly selected systematic soil samples will be analyzed by alpha spectroscopy for ^{239}Pu and ^{235}U.
- At the Building 351A Crawl Space and adjacent TUs 115 and 97 (**Figure 3-1**), where ^{239}Pu and ^{232}Th are ROCs, at least 10 percent of randomly selected systematic soil samples will be analyzed by alpha spectroscopy for ^{239}Pu and ^{232}Th.
- At TUs 107 and 116 (**Figure 3-1**), adjacent to Building 408 where ^{232}Th was an ROC, at least 10 percent of randomly selected systematic soil samples will be analyzed by alpha spectroscopy for ^{232}Th.

If the results following the full ingrowth are below the RGs shown in **Table 3-5**, additional analyses are not required.

All laboratory data packages will have independent data verification and data validation performed to demonstrate that the data meet the project objectives. Following independent data verification and validation, the sample data will be evaluated as described in **Section 5**.

Building Investigation Design and Implementation

This section describes the DQOs, ROCs, RGs, ILs, and radiological investigation design and implementation for Parcel G buildings.

4.1 Data Quality Objectives

The DQOs for the building investigation are as follows:

- **Step 1-State the Problem**: Data manipulation and falsification were committed by a contractor during past building surveys. The Technical Team evaluated building data and found evidence of potential manipulation and falsification. The findings call into question the reliability of the data and there is uncertainty whether radiological contamination was present or remains in place. Therefore, the property is unable to be transferred as planned. Based on the uncertainty and the description of radiological activities in the HRA, there is a potential for residual radioactivity to be present on building interior surfaces.
- **Step 2-Identify the Objective**: The primary objective is to determine whether site conditions are compliant with the Parcel G ROD RAO (Navy, 2009).
- **Step 3-Identify Inputs to the Objective**: The inputs include alpha-beta static, alpha and beta scan, and alpha-beta swipe data on building and reference area surfaces.
- **Step 4-Define the Study Boundaries**: The study boundaries are accessible interior surfaces of Buildings 351, 351A, 366, 401, 411, and 439, and the concrete pad at former Building 408 (**Figure 4-1**). The building floor (i.e., Class 1 SUs) are depicted on **Figures 4-2** through **4-8**.
- **Step 5-Develop Decision Rules:**
  - If the investigation results demonstrate that there are no exceedances determined from a point-by-point comparison with the statistically-based RGs[8] at agreed upon statistical confidence levels, or that residual ROC concentrations are NORM or anthropogenic background, then a RACR will be developed.
  - If the investigation results demonstrate exceedances of the RGs determined from a point-by-point comparison with the statistically-based RGs[8] at agreed upon statistical confidence levels and are not shown to be NORM or anthropogenic background, then remediation will be conducted, followed by a RACR.
  - The RACR will describe the results of the investigation, explain remediation performed, compare the distribution of data from the sites with applicable reference area data, and provide a demonstration that site conditions are compliant with the Parcel G ROD RAO through the use of multiple lines of evidence including application of statistical testing with agreed upon statistical confidence levels on the background data.

[8] The RGs are statistically based because they are increments above a statistical background.

- **Step 6-Specify the Performance Criteria:** The data evaluation process for demonstrating compliance with the Parcel G ROD is presented as follows, depicted on **Figure 4-9**, and described in detail in **Section 5**:
  - Compare each net alpha and net beta result to the corresponding RG presented in **Section 4.3**. If all results are less than or equal to the RGs, then compliance with the ROD RAO is achieved.
  - Compare survey data to appropriate RBA data from HPNS as described in **Section 5**. Multiple lines of evidence will be evaluated to determine whether site conditions are consistent with NORM or anthropogenic background. The data evaluation may include, but is not limited to, population-to-population comparisons, use of an MLE or BTV, and graphical comparisons. If survey data are consistent with NORM or anthropogenic background, site conditions comply with the Parcel G ROD RAO.
  - If any result is greater than the RG and cannot be attributed to NORM or anthropogenic background, remediation will be conducted.
- **Step 7-Develop the Plan for Obtaining Data:** Radiological investigations will be conducted on floors, wall surfaces, and ceiling surfaces, and will consist of alpha and beta scan surveys, alpha-beta static measurements, and alpha-beta swipe samples as described herein.

4.2 Radionuclides of Concern

The ROCs for Parcel G buildings, as identified in the HRA and in subsequent investigations, include ^{137}Cs, ^{60}Co, ^{239}Pu, ^{226}Ra, ^{90}Sr, and ^{232}Th and are presented in **Table 4-1**.

Table 4-1. Building Radionuclides of Concern

Building	ROCs	Reference
Building 351	^{137}Cs, ^{226}Ra, ^{90}Sr, ^{232}Th	NAVSEA, 2004
Building 351A	^{137}Cs, ^{239}Pu, ^{226}Ra, ^{90}Sr, ^{232}Th	NAVSEA, 2004
Building 366	^{137}Cs, ^{226}Ra, ^{90}Sr	NAVSEA, 2004
Building 401	^{137}Cs, ^{226}Ra, ^{90}Sr	TtEC, 2009c
Building 408	^{137}Cs, ^{226}Ra, ^{90}Sr, ^{232}Th	NAVSEA, 2004
Building 411	^{137}Cs, ^{60}Co, ^{226}Ra	NAVSEA, 2004
Building 439	^{137}Cs, ^{226}Ra	TtEC, 2009a

4.3 Remediation Goals

The building data from the radiological investigations will be evaluated to determine whether site conditions are compliant with the RAO in the Parcel G ROD (Navy, 2009). The RAO is to prevent exposure to ROCs in concentrations that exceed RGs for all potentially complete exposure pathways. These RGs for structures, equipment, and waste are presented in **Table 4-2** for each of the ROCs identified for the applicable buildings. Also identified for each ROC is the primary particle type emitted during the ROC's decay or during the ROC's radioactive progeny's decay.

Table 4-2. Building Remediation Goals from Parcel G ROD

ROC	Particle Emissions	RGs for Structures (dpm/100 cm^2)	RGs for Equipment, Waste (dpm/100 cm^2)
^{137}Cs	β	5,000	5,000
^{60}Co	β	5,000	5,000
^{239}Pu	α	100	100
^{226}Ra	α, β	100	100
^{90}Sr	β	1,000	1,000
^{232}Th	α, β	36.5	1,000

dpm/100 cm^2 = disintegration(s) per minute per 100 square centimeters

Data collected from building surfaces during this investigation represent the total (fixed and removable) gross activity on the surface, which may result from radiations from multiple radionuclides. Because these survey data are radiation-specific (α and β) but not radionuclide-specific, they cannot be attributed to a particular ROC. Instead, the survey data will be compared to the most restrictive building-specific RG_α and RG_β as presented in **Table 4-3**. For each building, the RG_α is chosen as the structure's lowest RG for an alpha-emitting ROC, and the RG_β is chosen as the structure's lowest RG for a beta-emitting ROC.

Table 4-3. Building-specific Remediation Goals for Parcel G Work Plan

Building	RG_α (dpm/100 cm^2) and ROC	RG_β (dpm/100 cm^2) and ROC
Building 351	36.5 (^{232}Th)	1,000 (^{90}Sr)
Building 351A	36.5 (^{232}Th)	1,000 (^{90}Sr)
Building 366	100 (^{226}Ra)	1,000 (^{90}Sr)
Building 401	100 (^{226}Ra)	1,000 (^{90}Sr)
Building 408 slab	36.5 (^{232}Th)	1,000 (^{90}Sr)
Building 411	100 (^{226}Ra)	5,000 (^{137}Cs)
Building 439	100 (^{226}Ra)	5,000 (^{137}Cs)

4.4 Radiological Investigation Design

This section describes the design of radiological investigations, including scan and static measurements on building surfaces. The radiological investigation design is based on methods, techniques, and instrument systems in the Basewide Radiological Management Plan (TtEC, 2012), with the ultimate requirement to demonstrate compliance with the Parcel G ROD RAO.

The principal features of the investigation protocol to be applied to the Parcel G building SUs are discussed herein and include the following:

- Determine the SUs.
- Select survey instruments.
- Determine instrument ILs and MDCs.

To the extent possible, manual data entries will be eliminated through use of electronic data collection and transfer processes.

4.4.1 Building Survey Overview

The radiological surveys of the impacted Parcel G buildings have two primary components (scanning measurements and static measurements), which are discussed in subsections 4.4.1.1 and 4.4.1.2. In addition, swipe samples will be collected to assess potential gross alpha and beta removable contamination. If needed, swipe samples will be analyzed offsite to speciate the radionuclides present. Building material samples may be collected and analyzed offsite to characterize areas of interest identified by the surveys.

4.4.1.1 Scanning Measurements

Scanning measurements are performed on building surfaces to locate radiation anomalies indicating residual radioactivity that may require further investigation or remediation. As noted in **Section 4.3**, the scanning design is dictated by the most restrictive RG_{α} and RG_{β} values for the building. Where appropriate, scanning measurements will be performed using the assumptions of equilibrium described in **Section 4.5.5**.

4.4.1.2 Static Measurements

Static measurements will be the primary means of demonstrating compliance with the Parcel G ROD RAO. Gross alpha and beta static measurements will be performed so that the measurement MDC is below the most restrictive RG_{α} and RG_{β} values for the building.

Static measurements will be performed in each SU and in the RBAs. They will consist of measurements in scaler mode for simultaneous alpha-beta counting using a Ludlum Model 43-68 gas proportional detector, Ludlum Model 43-93 plastic scintillation detector, or other appropriate instrument. While 1-minute count times were used in the following example calculations, static count times will be updated during investigations to meet DQOs using instrument-specific information. Static measurements will be performed on a systematic sampling grid or biased to locations identified by the alpha-beta scanning surveys.

The number of systematic static measurements performed will be based on the guidance described in MARSSIM Section 5.5.2.2 (USEPA et al., 2000) using the unity rule as the example basis for calculating the minimum static measurement frequency. Even if the MARSSIM-recommended or other statistical tests are not used to evaluate site data, these calculations serve as a basis for determining the number of static measurements per SU to be performed. The number of biased static measurements will be determined based on results of scan surveys.

MARSSIM Section 5.5.2.2 defines the method for calculating the number of static measurements when residual radioactivity is uniformly present throughout an SU. Therefore, determining the number of static measurements will be based on the following factors:

- RG for radioactivity on structural surfaces (UBGR)
- LBGR
- Estimate of variability (standard deviation [σ]) in the reference area and the SUs
- Shift (Δ=UBGR-LBGR)
- Relative shift ([UBGR-LBGR]/σ); see **Equation 4-1**
- Decision error rates for making a Type I or Type II decision error that the mean or median concentration exceeds the RG (determined via MARSSIM Table 5.2)

Each of the preceding factors is addressed in the following paragraphs. Example data are provided to assist in explaining the process for calculating the minimum static measurement frequency. Actual numbers of static measurements for SUs will be based on reference area data once they become available. When using the unity rule, the RG is defined as 1 (unitless) plus background. As a basis for the calculations, the background surface activity concentration is assumed to be 0.5.

MARSSIM defines a gray region as the range of values in which the consequences of decision error on whether the residual surface activity is less than or exceeds the RG are relatively minor. The RG of 1 above background (0.5) was selected to represent the UBGR (1.5). The LBGR is the median concentration in the SU, and the retrospective power will be determined after the survey is completed. Given the absence of usable data prior to performing the investigation activities, MARSSIM Section 2.5.4 suggests arbitrarily selecting the LBGR as half the RG. Therefore, for this example, the LBGR = 0.5 + 0.5 = 1. Assuming the UBGR equals the RG, then Δ = 1.5 – 1.0 = 0.5 for this example.

MARSSIM defines σ as an estimate of the standard deviation of the measured values in the SU. Because SU data will not be available until the investigation activities are completed, MARSSIM recommends using the standard deviation of the RBA as an estimate of σ. Given the absence of data prior to performing the investigation activities, an arbitrary value of 0.25 has been selected as an estimate of σ for this example.

The relative shift is calculated based on MARSSIM guidance (Section 5.5.2.2) as shown in **Equation 4-1**.

Equation 4-1

$$\frac{\Delta}{\sigma} = \frac{(UBGR - LBGR)}{\sigma} = \frac{(RG - LBGR)}{\sigma} = \frac{(1.5 - 1.0)}{0.25} = 2.0$$

The minimum number of samples assumes the ROC concentration in the SU exceeds the RG. Type I decision error is deciding that the ROC concentration in the SU is less than the RG when it actually exceeds the RG. To minimize the potential for releasing buildings with concentrations above the RG, the Type I decision error rate is set at 0.01. Type II decision error is deciding that the ROC concentration exceeds the RG when it is actually less than the RG. To protect against remediating building surfaces with concentrations below the RG, the Type II decision error rate is set at 0.05 as recommended by MARSSIM.

MARSSIM Table 5.3 lists the minimum number of static measurements to be performed in each SU and RBA based on the relative shift and decision error rates. For a relative shift of 2, a Type I decision error rate at 0.01, and Type II decision error rate of 0.05, MARSSIM Table 5.3 recommends a minimum of 18 static measurements in each SU and RBA.

Therefore, 18 static measurements are recommended as a placeholder until background data are available. The minimum number of static measurements per SU will be developed based on the variability observed in the RBA data. The DQA of SU data will include a retrospective power curve (based on the MARSSIM Appendix I guidance) to demonstrate that enough static measurements were performed to meet the project objectives. If necessary, additional static measurements may be performed to comply with the project objectives.

4.4.2 Radiological Background

Building 404 will serve as the primary RBA in the investigation of Parcel G buildings (**Figure 4-1**). Building 404 is a non-impacted, unoccupied former supply storehouse constructed in 1943 (see Reference 1598 in NAVSEA, 2004). From the same construction era and with materials similar to those of the impacted Parcel G buildings, Building 404 has 43,695 square feet of concrete floors, a wooden superstructure, prepared roll or composition roof, and drywall offices.

At least 18 static measurements will be taken on each surface material in the RBA that is representative of the material in the building SUs. Alternate RBAs may be identified and used if needed based on site-specific conditions identified during the building investigations.

4.4.3 Survey Units

Parcel G buildings will be divided into identifiable SUs similar in area and nomenclature to the previous investigation of each building. **Table 4-4** lists the SUs, classification, and areas by building. Generally, impacted floor surfaces and the lower 2 meters of remaining impacted wall surfaces will form Class 1 SUs of no more than 100 m^2 each. The remaining impacted upper wall surfaces and ceilings will generally form Class 2 SUs of no more than 2,000 m^2 each. Class 3 SUs consist of floor areas in Building 411 and the exterior of Building 366, which were investigated as part of past scoping surveys.

Several buildings on HPNS were remediated for lead and asbestos. This resulted in most of the interior wall and ceiling surfaces being removed, leaving only the wall structural components (i.e., wooden or metal framing). Areas with known releases have been remediated and recovered during past investigations such that there are no areas of suspected surface or volumetric contamination remaining in Parcel G buildings. This investigation measures only the remaining, accessible and impacted surfaces through a combination of scanning, static, and swipe measurements. The SU designations and floor boundaries will remain the same as those used in the historical TtEC investigations; however, the overall survey area will be reduced by the amount of area remediated for lead-based paint and asbestos.

The floor plans and floor SUs are shown for each building on **Figures 4-2** through **4-8**. Two example figures are provided that depict SU-specific details for a Class 1 SU (**Figure 4-10**) and a Class 2 SU (**Figure 4-11**). **Figure 4-10** is a two-dimensional representation of Building 366 (SU 1) and shows the Class 1 floors, remaining lower wall surfaces, and intended static measurement and swipe sample locations. **Figure 4-11** is a two-dimensional representation of Building 366 (SU 60) and shows the Class 2 upper walls, ceiling, and intended static measurement and swipe sample locations.

Additional building-specific information regarding the Parcel G buildings is provided in the following paragraphs and in **Table 4-4**.

4.4.3.1 Building 351A

There are 40 Class 1 SUs (SUs 1 to 3, 5 to 14, 16, 18 to 27, and 29 to 44) consisting of concrete flooring and concrete (perimeter and SU 6 interior) lower walls (**Figure 4-2**). There are three Class 2 SUs (SUs 45 to 47), which divide all the concrete perimeter upper walls and the concrete ceiling in SU 6. There are no other remaining ceilings. SUs 4, 15, 17, and 28 were originally surveyed by TtEC but incorporated into other SUs during past investigations and are no longer present.

The limiting alpha-emitting ROC for the Building 351A scans is ^{239}Pu, and for Building 351A static measurements is ^{232}Th. The limiting beta-emitting ROC is ^{90}Sr.

4.4.3.2 Building 351

There are 11 Class 1 SUs on the first floor (SUs 1 to 11) consisting of concrete flooring, concrete support columns, concrete perimeter lower walls, and asphalt cover over remediation trenches (**Figure 4-3**). There are 20 Class 1 SUs on the second floor (SUs 17 to 36) consisting of concrete flooring, concrete support columns, and concrete perimeter lower walls. There are no remaining interior lower wall surfaces on the first or second floors. There are 10 Class 1 SUs on the third floor (SUs 42 to 51) consisting of concrete flooring, concrete support columns, concrete perimeter lower walls, and metal interior lower walls around SU 45. There are five Class 2 SUs (SUs 39, 40, and 52 to 54). SU 39 is the Class 2 SU formed by the first floor concrete ceiling and concrete (perimeter) upper walls. SU 40 is the Class 2 SU formed by the second floor concrete ceiling and concrete (perimeter) upper walls. SU 52 is the Class 2 SU formed by the third floor concrete ceiling and concrete (perimeter) or metal (SU 45 interior) upper walls. SU 53 consists of the Class 2 areas with the stairwells, and SU 54 consists of the Class 2 floor, walls, and ceiling within the elevator. SU designations 12 to 16, 37, 38, and 41 were originally surveyed by TtEC but incorporated into other SUs during past investigations and are no longer present.

The limiting alpha-emitting ROC for Building 351 is ^{232}Th, and the limiting beta-emitting ROC is ^{90}Sr.

4.4.3.3 Building 366

There are 45 Class 1 SUs (SUs 1 to 14, 18, 24 to 28, 31 to 38, and 43 to 59) consisting of concrete flooring and sheet metal (perimeter) or sheetrock (interior) lower walls (**Figure 4-4**). SU designations 15 to 17, 19 to 23, 29 and 30, and 39 to 42 were originally surveyed by TtEC but incorporated into other SUs during past investigations and are no longer present. There are nine Class 2 SUs (SUs 60 to 68) and one Class 3 SU (SU 69). SUs 60 to 63 divide the metal roof and perimeter metal upper walls into four Class 2 SUs. SUs 64 and 65 are the Class 2 areas formed by the metal gables at the building's western and eastern ends. SUs 66 to 68 are the Class 2 faces of metal firewalls in place on three roof trusses. The building exterior (SU 69) is a Class 3 SU. The mezzanine level in the southwest corner of the building is SU 70, which will be surveyed as a Class 1 SU if it can be safely accessed.

The limiting alpha-emitting ROC for Building 366 is ^{226}Ra, and the limiting beta-emitting ROC is ^{90}Sr.

4.4.3.4 Building 401

There are 26 Class 1 SUs on the first floor (SUs 1 to 22 and 32 to 35) consisting of concrete flooring, wooden or concrete perimeter lower walls, and sheetrock interior lower walls (**Figure 4-5**). There are seven Class 1 SUs on the second floor (SUs 24-29 and 36) consisting of wooden or metal flooring and wooden perimeter lower walls. There are no remaining impacted, interior lower wall surfaces on the second floor. SUs 30 and 31 divide the first floor upper walls and ceilings into two Class 2 SUs consisting of wood paneled, sheetrock, or wooden upper walls and the undersides of the second floor's wooden or metal floors. The upper walls and ceilings of the second floor, as well as the remaining of the building, were not considered impacted by the tenant's storage of gauges and were not previously surveyed. Portions of the second floor SUs include wooden flooring that is highly deteriorated and may not be safely accessible for survey.

The limiting alpha-emitting ROC for Building 401 is ^{226}Ra, and the limiting beta-emitting ROC is ^{90}Sr.

4.4.3.5 Building 408

The remaining concrete slab of the former building (**Figure 4-6**) will be investigated as a single Class 1 SU. A Class 2 buffer area (SU 2) surrounding the Class 1 SU will also be surveyed.

The limiting alpha-emitting ROC for Building 408 is ^{232}Th, and the limiting beta-emitting ROC is ^{90}Sr.

4.4.3.6 Building 411

There are five Class 1 SUs on the first floor (SUs 5 to 7 and 9 and 10) consisting of concrete flooring (**Figure 4-7**). Class 1 SUs are surrounded by two Class 2 SUs (SUs 8 and 11) consisting of concrete flooring and lower walls. The ground level floor surfaces surrounding the Class 2 SUs form two Class 3 SUs (SUs 3 and 4) consisting of concrete flooring or steel grating. SU 3 and SU 4 contain many deep and water-filled pits/sumps that were not previously surveyed because of safety and accessibility concerns. SU 2 forms a single Class 3 SU on the second floor and consists of concrete flooring. The third floor and mezzanine are no longer accessible because of concerns about structural stability; therefore, the Class 3 SU 1 that was previously surveyed by TtEC is not included in this investigation. Access points to that area will be included with surveys of adjacent SUs.

The limiting alpha-emitting ROC for Building 411 is ^{226}Ra, and the limiting beta-emitting ROC is ^{137}Cs.

4.4.3.7 Building 439

The radiologically impacted area within Building 439 is an enclosed area that was historically leased to Young Laboratories. The original survey area consisted of two Class 1 SUs (SU 1 and SU 2) on the floors and lower walls of the enclosure, and a Class 2 SU (SU 3) on the enclosure's upper walls and ceiling (**Figure 4-8**). After remediation was performed in a small area within SU 1, a new Class 1 SU (SU 4) was established within the remediated area. In addition, two Class 2 SUs were established as buffer areas within the enclosure and in a 2-meter perimeter on the outside of the enclosure (SUs 5 and 6, respectively). Because of the overlap of the pre- and post-remediation SUs, the investigation at Building 439 will consist of Class 1 surveys in SUs 1 and 2, and Class 2 surveys in SUs 3 and 6. The Class 1 survey in SU 1 will capture areas previously surveyed as SUs 4 and 5.

The limiting alpha-emitting ROC for Building 439 is ^{226}Ra, and the limiting beta-emitting ROC is ^{137}Cs.

4.4.4 Reference Coordinate System

Survey unit scan lanes and static measurement locations will be marked using a consistent reference coordinate system throughout the building. In the absence of other technologies, locations will reference from the southernmost and westernmost points in the SU.

4.5 Instrumentation

Investigation data will be collected using position-sensitive proportional counters (PSPCs), gas proportional counters, and swipe sample counters as described herein.

4.5.1 Position-sensitive Proportional Counters

Large area surface scanning and static measurements for alpha and beta radiations will be performed using PSPCs such as the Radiation Safety and Control Services, Inc. (RSCS) Surface Contamination Monitor (SCM) or equivalent instrument. The RSCS SCM simultaneously acquires alpha-beta data from motor-controlled dual detectors moving over a surface at a fixed rate between 1.25 and 12.5 centimeters per second (cm/s). Detector functions, movement, and response are controlled through a Survey Information Management System (SIMS). The SIMS is also used to log, display, and interpret investigation data and generate survey reports. The detectors are configured in parallel and the system can identify the location of each reading within 5 cm along a detector's length. Operated in rolling (dynamic) mode for scanning, the SCM acquires data for each 5 cm of detector width and every 5 cm of forward travel. The data for the resulting 25-square-centimeter (cm^2) area is binned, then combined as one-fourth of the overall 100 cm^2 response.

4.5.2 Gas Proportional Detectors

Gas proportional detectors, such as the large area Ludlum Model 43-37, small area Ludlum Model 43-68, or equivalent instruments, will be used for scanning measurements in areas that are not accessible to or practicable for the RSCS SCM. The Ludlum Model 43-37 detector physical size is 2.5 by 15.9 by 46.4 cm (H by W by L) with an active area of 584 cm^2. The Ludlum Model 43-68 is 10 by 11.7 by 19.8 cm, with an active area of 126 cm^2. Scanning speed is surveyor-controlled, and data are automatically logged when used with an appropriate data-logging scaler/ratemeter, such as the Ludlum Model 2360 or equivalent. The Ludlum Model 43-68 may also be used to perform static measurements.

4.5.3 Scintillation Detectors

Alpha-beta scintillation detectors may also be used for scanning and static measurements. The Ludlum Model 43-93 has an active detector area of 100 cm^2 and simultaneously counts alpha radiation using a zinc sulfide scintillator and beta radiation using a thin plastic scintillator.

4.5.4 Alpha-Beta Sample Counter

Swipe samples to assess removable activity will be performed using an alpha-beta plastic scintillation counter, such as the Ludlum Model 3030 Alpha-Beta Sample Counter or equivalent. The Ludlum Model 3030 has an active detector area of 20.3 cm^2 and simultaneously counts alpha-beta radiation from 5.1 cm swipe papers loaded into a single sample tray.

4.5.5 Instrument Efficiencies

Manufacturer-provided parameters are provided in **Table 4-5**, including the detector physical (active) areas, detector widths in the direction of scanning, total (4π) efficiencies, and background count rates. These parameters will be updated during the investigation for each instrument used.

Table 4-5. Typical Survey Instrument Efficiencies and Background Count Rates from Manufacturers

Parameter	RSCS SCM	Ludlum Model 43-37	Ludlum Model 43-68	Ludlum Model 43-93	Ludlum Model 3030
Type of Measurement	**Scanning**	**Scanning**	**Scanning/Static**	**Scanning/Static**	**Smear Counting**
Detector active area, *A* (cm^2)	100	584	126	100	20.3
Width in direction of scan, *d* (cm)	20	13.335	8.8	6.94	NA
Alpha total efficiency (4π) for ^{239}Pu		0.175	0.175	0.20	0.37
Alpha total efficiency (4π) for ^{235}U	NA	NA	NA	NA	0.39
Alpha total efficiency (4π) for ^{230}Th		NA	NA	NA	0.32
Alpha total efficiency (4π) for ^{226}Ra	0.188	NA	NA	NA	NA
Beta total efficiency (4π) for ^{99}Tc		0.20	0.20	0.15	0.27
Beta total efficiency (4π) for $^{90}Sr/^{90}Y$	0.90	0.20	0.20	0.20	0.26
Beta total efficiency (4π) for ^{137}Cs		NA	NA	NA	0.29
Alpha background (cpm)	1	< 10	≤ 3	≤ 3	≤ 3
Beta background (cpm)	636	800 - 1300	350	≤ 300	≤ 50

Notes:

^{90}Y = yttrium-90

^{99}Tc = technetium-99

< = less than

≤ = less than or equal to

NA = not applicable

The response of a detector to the incident radiations from building surfaces differs from the values in **Table 4-5** depending on the presence and state of equilibrium of radioactive progenies. Of the ROCs in **Table 4-1**, ^{226}Ra, ^{90}Sr, and ^{232}Th have radioactive progenies that emit alpha or beta particles during their decay. The concentration of each progeny relative to its parent depends on its parent's decay fraction and the equilibrium fraction of the entire series or chain. ^{226}Ra and ^{232}Th both have radon isotopes as progeny. Because both radon (^{222}Rn) and thoron (^{220}Rn) are gases, a fraction of their concentration may escape the building area before decaying, and the relative abundance (equilibrium fraction) of the subsequent progenies is reduced. For the ^{226}Ra decay series, the radon decay products typically have a 0.4 equilibrium fraction indoors (see Question 17 in USEPA, 2014) such that the progeny of radon (^{222}Rn) is only present at 40 percent of the ^{222}Rn concentration. Similarly, for the ^{232}Th decay series, the radon decay products typically have a 0.02 equilibrium fraction indoors (see Question 17 in USEPA, 2014) such that the progeny of thoron (^{220}Rn) is only present at 2 percent of the ^{220}Rn concentration.

In **Table 4-6**, each ROC and its progeny is listed along with the associated type of particle emitted during decay, the fraction of times that particle type is emitted, the radon decay product abundance relative to ^{222}Rn or ^{220}Rn, and the 4-π efficiencies and 4-π weighted efficiencies for the three example detector types for building investigations. The 4-π weighted efficiencies for each radionuclide and detector is the product of its decay fraction, equilibrium fraction, and 4-π efficiency. The total alpha (or beta) 4-π weighted efficiencies for ^{226}Ra, ^{90}Sr, and ^{232}Th are the summed alpha (or beta) 4-π weighted efficiencies of themselves and their progeny. To illustrate, the alpha response (4-π efficiency) of the RSCS SCM to pure ^{226}Ra is 0.188 (or 18.8 counts per 100 disintegrations of ^{226}Ra). However, ^{226}Ra exists in partial equilibrium with its radioactive progeny, and for each disintegration of ^{226}Ra, there are 3.2 alpha particles and 1.6 beta particles formed. The resultant total alpha 4-π weighted efficiency for the RSCS SCM and the ^{226}Ra chain is 0.188 x 3.2 = 0.602. Consistent with Section 4.3.2 of MARSSIM (USEPA et al., 2000), the weighted efficiencies provided in **Table 4-6** are used for the instrument sensitivity calculations described in the remainder of this section.

Table 4-6. Detector Efficiencies for Each ROC and Alpha- or Beta-emitting Progeny

				4π Efficiencies (Estimated)					4π Weigh	
Parent ROC and Alpha- or Beta-emitting Progenies	**Particle Emission**	**Decay Fraction**	**Equilibrium Fraction**	**RSCS SCM**	**Ludlum Model 43-37**	**Ludlum Model 43-68**	**Ludlum Model 43-93**	**Ludlum Model 3030**	**RSCS SCM**	**Ludlu Mod 43-3**
^{137}Cs	Beta	1.00	1.00	0.900	0.200	0.200	0.200	0.290	0.900	0.20
^{60}Co	Beta	1.00	1.00	0.900	0.200	0.200	0.150	0.270	0.900	0.20
^{239}Pu	Alpha	1.00	1.00	0.188	0.175	0.175	0.200	0.370	0.188	0.17
^{226}Ra	Alpha	1.00	1.00	0.188	0.175	0.175	0.200	0.320	0.188	0.17
^{222}Rn	Alpha	1.00	1.00	0.188	0.175	0.175	0.200	0.370	0.188	0.17
^{218}Po	Alpha	1.00	0.40	0.188	0.175	0.175	0.200	0.370	0.075	0.07
^{214}Pb	Beta	1.00	0.40	0.900	0.200	0.200	0.200	0.260	0.360	0.08
^{214}Bi	Beta	1.00	0.40	0.900	0.200	0.200	0.200	0.260	0.360	0.08
^{214}Po	Alpha	1.00	0.40	0.188	0.175	0.175	0.200	0.370	0.075	0.07
^{210}Pb	Beta	1.00	0.40	0	0	0	0	0	0	0
^{210}Bi	Beta	1.00	0.40	0.900	0.200	0.200	0.200	0.260	0.360	0.08
^{210}Po	Alpha	1.00	0.40	0.188	0.200	0.175	0.200	0.370	0.075	0.08
		Total ^{226}Ra alphas	***3.20***						***0.602***	***0.57***
		Total ^{226}Ra betas	***1.60***						***1.080***	***0.24***
^{90}Sr	Beta	1.00	1.00	0.900	0.200	0.200	0.200	0.260	0.900	0.20
^{90}Y	Beta	1.00	1.00	0.900	0.200	0.200	0.200	0.260	0.900	0.20
		Total ^{90}Sr betas	***2.00***						***1.800***	***0.40***
^{232}Th	Alpha	1.00	1.00	0.188	0.175	0.175	0.200	0.390	0.188	0.17
^{228}Ra	Beta	1.00	1.00	0.900	0	0	0	0	0	0
^{228}Ac	Beta	1.00	1.00	0.900	0.200	0.200	0.200	0.260	0.1088	0.20
^{228}Th	Alpha	1.00	1.00	0.188	0.175	0.175	0.200	0.370	0.188	0.17
^{224}Ra	Alpha	1.00	1.00	0.188	0.175	0.175	0.200	0.370	0.188	0.17
^{220}Rn	Alpha	1.00	1.00	0.188	0.175	0.175	0.200	0.370	0.188	0.17
^{216}Po	Alpha	1.00	0.02	0.188	0.175	0.175	0.200	0.370	0.004	0.00
^{212}Pb	Beta	1.00	0.02	0.900	0.200	0.200	0.150	0.270	0.018	0.00
^{212}Bi	Beta	0.64	0.02	0.900	0.200	0.200	0.200	0.260	0.012	0.00
	Alpha	0.36	0.02	0.188	0.175	0.175	0.200	0.370	0.001	0.00
^{212}Po	Alpha	1.00	0.02	0.188	0.175	0.175	0.200	0.370	0.004	0.00
^{208}Tl	Beta	1.00	0.02	0.900	0.200	0.200	0.200	0.260	0.018	0.00
		Total ^{232}Th alphas	***4.05***						***0.761***	***0.70***

Table 4-6. Detector Efficiencies for Each ROC and Alpha- or Beta-emitting Progeny

				4π Efficiencies (Estimated)					4π Weigh	
Parent ROC and Alpha- or Beta-emitting Progenies	**Particle Emission**	**Decay Fraction**	**Equilibrium Fraction**	**RSCS SCM**	**Ludlum Model 43-37**	**Ludlum Model 43-68**	**Ludlum Model 43-93**	**Ludlum Model 3030**	**RSCS SCM**	**Ludlu Mode 43-3**
		Total ^{232}Th betas	***2.05***						***0.948***	***0.21***

Notes:

Total alphas or betas = sum of (decay fraction x equilibrium fraction)

^{208}Tl = thallium-208

^{210}Bi = bismuth-210

^{210}Pb = lead-210

^{210}Po = polonium-210

^{212}Bi = bismuth-212

^{212}Pb = lead-212

^{212}Po = polonium-212

^{214}Pb = lead-214

^{214}Po = polonium-214

^{216}Po = polonium-216

^{218}Po = polonium-218

^{224}Ra = radium-224

^{228}Ac = actinium-228

^{228}Ra = radium-228

^{228}Th = thorium-228

4.5.6 Calibration

Portable survey instruments will be calibrated annually at a minimum, in accordance with ANSI N323 (ANSI, 1997), or an applicable later version. Instruments will be removed from service on or before calibration due dates for recalibration. If ANSI N323 does not provide a standard method, the calibration facility should comply with the manufacturer's recommended method.

4.5.7 Daily Performance Checks

Before using the portable survey instruments, calibration verification, physical inspection, battery check, and source-response check will be performed in accordance with SOP RP-108, *Count Rate Instruments,* and SOP RP-109, *Dose Rate Instruments* (**Appendix D**). Portable survey instruments will have a current calibration label that will be verified daily before use.

Physical inspection of the portable survey instrument will include the following:

- General physical condition of the instrument and detector before each use
- Knobs, buttons, cables, connectors
- Meter movements and displays
- Instrument cases
- Probe and probe windows
- Other physical properties that may affect the proper operation of the instrument or detector

Any portable survey instrument or detector having a questionable physical condition will not be used until problems have been corrected. A battery check will be performed to ensure that sufficient voltage is being supplied to the detector and instrument circuitry for proper operation. This check will be performed in accordance with the instrument's operations manual. The instrument will be exposed to the appropriate (alpha or beta) check source, to verify that the instrument response is within the plus or minus 20 percent range determined during the initial response check. The calibration certificates and daily QA/QC records for each instrument used and the instrument setup test records will be provided in the project report.

If any portable survey instrument, or instrument and detector combination, having a questionable physical condition that cannot be corrected fails any of the operation checks stated in SOP RP-108, *Count Rate Instruments*, or SOP RP-109, *Dose Rate Instruments* (**Appendix D**), or has exceeded its annual calibration date without PRSO approval, the instrument will be put in an "out of service" condition. This is done by placing an "out of service" tag or equivalent on the instrument and securing the instrument or the instrument and detector combination in a separate area such that the instrument and instrument and detector combination cannot be issued for use. The PRSO and RCTs and their respective supervisors will be notified immediately when any survey instrumentation has been placed "out of service." Instruments tagged as "out of service" will not be returned to service until all deficiencies have been corrected. The results of the daily operation checks, discussed above, will be documented.

4.5.8 Instrument Detection Calculations and Investigation Levels

Instrument-specific parameters used for building investigations are calculated in the following sections. These include the average scan rate, ILs, alpha detection probabilities and MDCs for scanning measurements and the ILs and MDCs for static measurements. These calculations will be updated during building investigations (**Section 4.6.3**) using information from calibration sheets and background measurements for each instrument.

4.5.8.1 Scan Rate

While scanning, the period that a moving detector spends above an area of elevated activity, or the dwell time (in seconds), depends on the rate of scanning (cm/s) and the size of the area of elevated activity (cm^2). The detector dwell time (*t*) is also called the detector residence time or observation interval (*i*) in some references. The size of any area of elevated activity cannot be known before investigation, so the conventional approach is to assume a typical size for the area (e.g., 100 cm^2) and choose a scan rate that provides a reasonable value for *t*. Generally, dwell times in the 0.5- to 2-second range are considered reasonable. If the 100 cm^2 area of elevated activity is 10 cm x 10 cm, then these dwell times would result in average detector scan rates, v, between 5 and 20 cm/s.

Average scan rates for each instrument used for scanning will be determined during instrument preparations (**Section 4.6.3.1**) to meet required detection sensitivities. Movement of a PSPC, such as the RSCS SCM, is motor-controlled and has a fixed scan rate, v, which is typically between 1.25 and 12.5 cm/s. Movement of other large area detectors, such as the Ludlum Model 43-37, is surveyor-controlled and the average scan rate will be monitored during scanning and verified during data evaluation.

4.5.8.2 Scan Investigation Levels

Scan data are compared to scan ILs. ILs are instrument-, ROC-, and surface material-specific surface activity levels, in units of the instrument's response (cpm). Scan data that exceed an applicable scan IL will be investigated using biased measurements (**Section 4.6.3.4**). Scan ILs will be updated during instrument preparations (**Section 4.6.3.1**).

The measurements for alpha and beta surface activity occur simultaneously during scanning; however, the signal detection theory for alpha emitters differs greatly from that of beta emitters. Surface conditions and other factors result in relatively low probabilities that alpha particles emitted from sources on a surface will reach the detector, while beta scanning provides a more reliable and efficient method for the detection of beta emitters. Given that ^{226}Ra and ^{232}Th have progeny that emit beta particles, the collection of beta scanning measurements will supplement and verify alpha scans where ^{226}Ra and ^{232}Th are ROCs.

Scan ILs are calculated using **Equation 4-2** and the detector-specific information in **Table 4-5** and **Table 4-6**. To enable direct comparison to the alpha ratemeter output during scanning, the RG for each alpha-emitting ROC is converted from units of dpm/100 cm^2 to cpm (beta) using **Equation 4-2**, which is based on the discussion of data conversion in MARSSIM Section 6.6.1 (USEPA et al., 2000). The beta scan IL is determined in a similar manner.

Equation 4-2

$$\text{Scan IL}_{(\alpha \text{ or } \beta)}\ (\text{cpm}) = RG_{(\alpha\ or\ \beta)} \cdot \varepsilon_{T\ (\alpha\ or\ \beta)} \cdot \left(\frac{A}{100\ cm^2}\right) + R_{B\ (\alpha\ or\ \beta)}$$

Where:

$RG_{(\alpha \text{ or } \beta)}$	= remediation goal for alpha- or beta-emitting ROC (dpm/100 cm^2)
$\varepsilon_{T\ (\alpha\ or\ \beta)}$	= detector total (4-π) efficiency (counts per disintegration)
A	= detector probe physical (active) area (cm^2)
$R_{B\ (\alpha\ or\ \beta)}$	= alpha or beta background count rate (cpm)

For illustration, calculated scan ILs are presented in **Table 4-7** for each ROC and for three detector models. Site-specific scan ILs will be determined during instrument preparations (**Section 4.6.3.1**).

***<u>Example</u>**: ^{232}Th alpha scan IL for the RSCS SCM.*

$$\text{Scan IL}^{232}Th_{,\alpha}\ (\text{RSCS SCM}) = 36.5 \cdot 0.761 \cdot \left(\frac{100}{100}\right) + 1 = 28.8\ cpm$$

Where:

$RG^{232}Th_{,\alpha}$	= 36.5 dpm/100 cm^2
$\varepsilon_{T,\alpha}$	= 0.761 (total weighted efficiency for ^{232}Th)
A	= 100 cm^2 (combined area of four 25 cm^2 bins)
$R_{B,\alpha}$	= 1 cpm

Table 4-7. Preliminary Instrument Scan Investigation Levels

ROC	RSCS SCM (cpm)		Ludlum 43-37 (cpm)		Ludlum 43-68 (cpm)	
	Alpha	**Beta**	**Alpha**	**Beta**	**Alpha**	**Beta**
^{137}Cs	NA	5,136	NA	6,890	NA	1,435
^{60}Co	NA	5,136	NA	6,890	NA	1,435
^{239}Pu	19	NA	107	NA	23	NA
^{226}Ra	61	780	337	1,190	72	205
^{90}Sr	NA	2,436	NA	3,386	NA	679
^{232}Th	28	703	159	1,095	34	184

Notes:
NA = not applicable

4.5.8.3 Probability of Alpha Detection for High-background Detectors

The measurements for alpha and beta surface activity occur simultaneously during scanning; however, the signal detection theory for alpha emitters differs greatly from that of beta emitters. For alpha scanning, one verifies that while scanning at rate ν, there is a specified probability (typically 90 percent) that surface activity present at the RG_{α} will be detected.

Equation 4-3 (adapted from Equation 6-14 in MARSSIM [USEPA et al., 2000]) is used for detectors having higher background rates (i.e., 5 to 10 cpm) to determine the probability of recording at least two alpha counts, $P(n \geq 2)$, while passing over an area contaminated at the RG_{α}, during t. It is assumed that all the elevated activity is contained in a 100 cm^2 area and that the detector passes over the area in one or multiple scan passes.

To achieve the sensitivity needed to detect alpha-emitting ROCs at the release criteria, where possible the SCM will be used in the coincidence, with two detectors hard-mounted to each other at a set distance. The system will be operated at a target speed of 2.5 to 5 cm/s, with the detector approximately 0.5 inch from the surface. The probability of detecting two or more counts due to a source at the RG_{α} is given by Equation 4-3 (Equation 6-14 from MARSSIM [USEPA et al., 2000]), as follows:

Equation 4-3

$$P(n \geq 2) = 1 - \left(1 + \frac{(GE + B)t}{60}\right)\left(e^{\frac{-(GE+B)t}{60}}\right)$$

Where:

$P(n \geq 2)$	=	probability of getting two or more counts during the time interval t (percent)
t	=	time interval (seconds)
G	=	contamination activity (disintegrations per minute [dpm]) = equal to the RG_{α}
E	=	total efficiency (4-pi)
B	=	background count rate (cpm)

Because the detectors associated with the SCM are manufactured to the same specifications, the efficiency of each detector is similar. Therefore, the probability of obtaining two or more counts on each detector as they traverse the same source (assumed to be 36.5 dpm for the purposes of this calculation) is the square of the probability for a single detector.

Typical alpha background values observed with the SCM are less than 5 cpm/100 cm^2. The total detector efficiency (4-pi) of the SCM for the alpha emission from ^{232}Th is assumed to be 0.761, according to **Table 4-6**. The detector width is 20 cm in the direction of travel. Survey speed for alpha emitters is 2.5 cm/s (1 inch per second), resulting in a dwell time of 8 seconds. Using these parameters, **Equation 4-3** is solved as follows:

$$P(n \geq 2) = 1 - \left(1 + \frac{(36.5 \times 0.761 + 5)8}{60}\right)\left(e^{\frac{-(36.5 \times 0.761 + 5)8}{60}}\right) = 93.2\%$$

Where:

P(n ≥ 2)	=	probability of getting two or more counts during the time interval t
t	=	8 seconds
G	=	36.5 dpm
E	=	0.761 (total weighted efficiency for ^{232}Th alphas from **Table 4-6**)
B	=	5 cpm

As calculated above, the probability of getting two or more counts during the SCM observation interval of 4 seconds when surveying a 36.5-dpm hotspot is equal to 93.2 percent at a scan speed of 2.5 cm/s. Alpha detection probabilities and associated scan speeds for large area detectors will be updated as needed during survey preparation (**Section 4.6.3.1**) to reflect instrument-, ROC-, and surface material-specific information.

4.5.8.4 Probability of Alpha Detection for Small Area Detectors

The alpha count rate on various surfaces will average approximately 2 cpm with a small area Ludlum Model 43-68 detector. When using a 126 cm^2 or smaller detector, scanning for alpha emitters differs because the expected background response of most alpha detectors is close to zero. A single count in the defined residence time will result in a second measurement of equal duration. One or more additional counts will require investigation with a static measurement as described in **Section 4.6.3.4**.

The probability of detecting given levels of alpha surface contamination for smaller detectors can be calculated by use of Poisson summation statistics. Given a known measurement interval and a surface contamination release limit, the probability of detecting a single count for the measurement interval to be used during this project and sample data from a typical Ludlum Model 43-68 setup is given by Equation 6-12 of MARSSIM (USEPA et al., 2000), shown as **Equation 4-4**:

Equation 4-4

$$P(n \geq 1) = 1 - e^{\frac{-(GEd)}{60v}}$$

Where:

P(n ≥ 1)	=	probability of observing a single count
G	=	contamination activity = RG_{α}
E	=	total efficiency (4-pi)
d	=	width of detector in direction of scan (cm)
v	=	scan speed (cm/s)
B	=	background count rate

Equation 4-4 may be solved as follows:

$$P(n \geq 1) = 1 - e^{\frac{-(36.5 \times 0.708)8.8}{60x2.5}} = 78.1\%$$

Where:

$P(n \geq 1)$	=	probability of observing a single count
G	=	36.5 dpm
E	=	0.708 (**Table 4-6**)
d	=	8.8 cm
v	=	5 cm/s

As calculated above, the probability of getting one or more counts during a Ludlum Model 43-68 scan moving at 2.5 cm/s when surveying a 36.5-dpm hotspot is equal to 78.1 percent. Alpha detection probabilities and associated scan speeds for small area detectors will be updated as needed during survey preparation (**Section 4.6.3.1**) to reflect instrument-, ROC-, and surface material-specific information.

4.5.8.5 Beta Scan Minimum Detectable Concentration

The rate at which each detection instrument traverses across the surface being surveyed is necessarily detector- and radionuclide-specific and varies with accepted error rates, surveyor efficiency, and surface beta background. We assume that 95 percent true positive (α = 0.95) and 5 percent false positive (β = 0.95) rates are required, such that d' = 3.28 from MARSSIM Table 6.5. A value of 0.5 for *p*, the surveyor efficiency, is typical for surveyor-controlled detectors and 1.0 for motor-controlled detectors. The β scan MDC is calculated using **Equation 4-5** (adapted from MARSSIM, Equation 6-10 [USEPA et al., 2000]). Instruments will be selected for scanning to ensure that their beta scan MDC is less than or equal to the RG_β for the building from **Table 4-3**. **Equations 4-5** through **4-7** are derived as follows:

Equation 4-5

$$\beta\ scan\ MDC\ (\mathrm{dpm/100\ cm^2}) = \frac{MDCR}{\sqrt{p}\cdot\varepsilon_{i,\beta}\cdot\varepsilon_{s,\beta}\cdot\dfrac{A}{100\ cm^2}}$$

Where:

MDCR	= minimum detectable count rate
p	= surveyor efficiency
$\varepsilon_{i,\beta}$	= detector (2-π) beta efficiency (counts per disintegration)
$\varepsilon_{s,\beta}$	= surface (2-π) beta efficiency (counts per disintegration)
A	= detector physical (active) area (cm^2)

Substituting $MDCR = 60 \cdot s_i/i$ (MARSSIM Equation 6-9), $t = i$, $s_i = d' \cdot (b_i)^{1/2}$ (MARSSIM Equation 6-8) and $\varepsilon_{T,\beta} = \varepsilon_{i,\beta} \cdot \varepsilon_{s,\beta}$ yields **Equation 4-6**:

Equation 4-6

$$\beta\ scan\ MDC\ (\mathrm{dpm/100\ cm^2}) = \frac{60\cdot s_i/t}{\sqrt{p}\cdot\varepsilon_{T,\beta}\cdot\dfrac{A}{100\ cm^2}} = \frac{60\cdot d'\cdot\sqrt{b_i}/t}{\sqrt{p}\cdot\varepsilon_{T,\beta}\cdot\dfrac{A}{100\ cm^2}}$$

Where:

s_i	= minimum detectable net source counts in *t*
d'	= index of sensitivity (for error rates α and β)
b_i	= background counts in *t*
t	= d/ν = detector dwell time (seconds)
d	= width of detector in direction of scan (cm)
ν	= average scan rate (cm/s)
$\varepsilon_{T,\beta}$	= detector total (4-π) beta efficiency (counts per disintegration)

Substituting $b_i = R_{B,\beta}$ (cpm)$\cdot t$ (seconds)/60 yields **Equation 4-7**:

Equation 4-7

$$\beta\ scan\ MDC\ (\text{dpm}/100\ \text{cm}^2) = \frac{d' \cdot \sqrt{R_{B,\beta} \cdot \frac{t}{60} \cdot \frac{60}{t}}}{\sqrt{p} \cdot \varepsilon_{T,\beta} \cdot \frac{A}{100}}$$

Where:

$R_{B,\beta}$ = background beta count rate (cpm)

The beta scan MDCs for each scan survey instrument and ROC are presented in **Table 4-8** for various detector average scan rates.

Example*: Beta Scan MDC Calculation for the RSCS SCM.*

The β scan MDC is calculated for the RSCS SCM scanning for beta emitters at 5 cm/s and using the parameters presented in **Table 4-5** and **Table 4-6**. Because the scan rate is motor-controlled and there are no scanning pauses, the surveyor efficiency, *p*, is 100 percent.

$$\beta\ \text{scan MDC (RSCS SCM, } ^{137}\text{Cs)} = \frac{3.28 \cdot \sqrt{636 \cdot \frac{4.0}{60} \cdot \frac{60}{4.0}}}{\sqrt{1.0} \cdot 0.900\ \cdot \frac{100}{100}} = 356.0\ \text{dpm}/100\ \text{cm}^2$$

Where:

d' = 3.28 (for 95% true positive and 5% false positive)

$R_{B,\beta}$ = 636 cpm

t = d/v = 20 cm/(5 cm/s) = 4 seconds

p = 1

$\varepsilon_{T,\beta}$ = 0.900 for beta emitters

A = 100 cm^2

Table 4-8. Beta Scan Minimum Detectable Concentrations (dpm/100 cm^2) at 5 cm/s

	Scan Rate (5 cm/s)	
ROC	**RSCS SCM**	**Ludlum Model 43-37**
^{137}Cs	356	610
^{60}Co	356	610
^{226}Ra	297	509
^{90}Sr	178	305
^{232}Th	338	580

Table 4-8 demonstrates that at a scan rate for the RCSC SCM of 5 cm/s, the beta scan MDCs for all ROCs are below the most restrictive RG_β (1,000 dpm/100 cm^2 for ^{90}Sr) for both large area survey instruments. Beta scan MDCs and associated scan speeds will be updated as needed during survey preparation (**Section 4.6.3.1**) to reflect instrument-, ROC-, and surface material-specific information.

4.5.8.6 Static Investigation Levels

Static measurement data are compared to static ILs. Static measurement data that exceed an applicable static IL will be investigated using biased measurements (**Section 4.6.3.4**).

The alpha and beta static ILs are determined using the static measurement count time in **Equation 4-8**, which is based on the discussion of data conversion in MARSSIM Section 6.6.1 (USEPA et al., 2000). Static ILs will be updated as needed during survey preparation (**Section 4.6.3.1**) using instrument-, ROC- and surface material-specific information.

Equation 4-8

$$\text{Static IL}_{(\alpha \text{ or } \beta)}\ (\text{counts}) = \left[RG_{(\alpha\ or\ \beta)} \cdot \varepsilon_{T(\alpha\ or\ \beta)} \cdot \left(\frac{A}{100\ cm^2}\right) + R_{B(\alpha\ or\ \beta)}\right] \cdot T_{S+B}$$

Where:

$RG_{(\alpha \text{ or } \beta)}$	= remediation goal for alpha- or beta-emitting ROC (dpm/100 cm^2)
$\varepsilon_{T(\alpha\ or\ \beta)}$	= detector total (4-π) efficiency (counts per disintegration)
A	= detector probe physical (active) area (cm^2)
$R_{B(\alpha\ or\ \beta)}$	= alpha or beta background count rate (cpm)
T_{S+B}	= SU static counting time (minutes)

For illustration, the following example calculates the alpha static IL equivalent to the ^{232}Th RG for the Ludlum Model 43-93, on concrete, using a 1-minute static count time.

***<u>Example</u>**: Alpha static IL for the Ludlum Model 43-93*

$$\text{Static IL}_{\alpha}\ \left(\text{Ludlum Model 43-93, } ^{232}Th\right) = \left[36.5 \cdot 0.200 \cdot \left(\frac{100}{100}\right) + 1\right] \cdot 1 = 8.3\ \text{counts}$$

Where:

$RG^{232}Th_{,\alpha}$	= 36.5 dpm/100 cm^2
$\varepsilon_{T,\alpha}$	= 0.200 (total efficiency for ^{232}Th, **Table 4-6**)
A	= 100 cm^2
$R_{B,\alpha}$	= 1 cpm
T_{S+B}	= 1 minute

4.5.8.7 Alpha Static Minimum Detectable Concentration

Simultaneous static alpha-beta (paired) measurements are typically taken with alpha-beta detectors coupled to scaler and ratemeter data loggers, and operated in scaler mode for the counting time, T. The division of counting times between background counting time, T_B, and SU counting time, T_{S+B}, is optimized such that the static MDCs will be less than or equal to the RG_α for the building from **Table 4-3**. The static MDC is the a priori net activity concentration above the critical level that is expected to be detected 95 percent of the time. When the count times for the background and SU measurements are different, the static MDC, for either alpha or beta activity, is calculated using **Equation 4-9** (adapted from Strom and Stansbury, 1992). Any areas of elevated activity are assumed to be 100 cm^2 in size. MDC calculations for static measurements will be updated during survey preparations (**Section 4.6.3.1**) using instrument-, ROC-, and surface material-specific information.

Equation 4-9

$$\text{Static MDC}\ (\text{dpm}/100\ \text{cm}^2) = \frac{\left[3 + 3.29\sqrt{R_B \cdot T_{S+B} \cdot \left(1 + \frac{T_{S+B}}{T_B}\right)}\right]}{\varepsilon_T \cdot \frac{A}{100} \cdot T_{S+B}}$$

Where:

R_B	= background count rate (cpm)
T_{S+B}	= SU counting time (minutes)
T_B	= background counting time (minutes)
ε_T	= detector total (4-π) efficiency (counts per disintegration)
A	= detector probe physical (active) area (cm^2)

Instruments will be selected for static measurements to ensure that their alpha static MDC is less than or equal to the RG_α for the building from **Table 4-3.**

***Example**: Alpha Static MDC Calculation for the Ludlum Model 43-93.*

The α static MDC is calculated for the Ludlum Model 43-93 using the parameters presented in **Table 4-5** and **Table 4-6**. Using **Equation 4-9**, the calculated α static MDC for ^{239}Pu is 30.8 dpm/100 cm^2.

$$\alpha \text{ Static MDC } \left(43\text{-}93,\ ^{239}\text{Pu}\right) = \frac{\left[3 + 3.29\sqrt{2 \cdot 2 \cdot \left(1 + \frac{2}{2}\right)}\right]}{0.200 \cdot \frac{100}{100} \cdot 2} = 30.8 \text{ dpm/100 cm}^2$$

Where:

$R_{B,\alpha}$ = 2 cpm
T_{S+B} = 2 minutes
T_B = 2 minutes
$\varepsilon_{T,\alpha}$ = 0.200
A = 100 cm^2

4.5.8.8 Beta Static Minimum Detectable Concentration

Beta static MDC calculations are also performed using **Equation 4-9** and information from **Table 4-5** and **Table 4-6**. Instruments will be selected for static measurements to ensure that their beta static MDC is less than or equal to the RG_β for the building from **Table 4-3.** MDC calculations for static measurements will be updated during survey preparations (**Section 4.6.3.1**) using instrument-, ROC-, and surface material-specific information.

The alpha and beta static MDCs for each survey instrument and ROC are presented in **Table 4-9** for 1-minute measurements in the SUs and RBAs.

Table 4-9. Instrument Static Minimum Detectable Concentrations

	Ludlum Model 43-68 (dpm/100 cm^2)		**Ludlum Model 43-93 (dpm/100 cm^2)**		**Ludlum Model 3030 (dpm/100 cm^2)**	
ROC	Alpha	Beta	Alpha	Beta	Alpha	Beta
^{137}Cs	NA	178.7	NA	225.1	NA	90.6
^{60}Co	NA	178.7	NA	300.2	NA	97.3
^{239}Pu	27.9	NA	30.8	NA	23.5	NA
^{226}Ra	27.9	148.9	30.8	187.6	7.67	84.2
^{90}Sr	NA	178.7	NA	225.1	NA	47.8
^{232}Th	27.9	169.7	30.8	214.8	5.73	95.9

Notes:
SU background static measurement count times = 2 minutes.
NA = not applicable

4.6 Radiological Investigation Implementation

Investigations will be generally implemented in the following order of activities: premobilization/mobilization, surveys, additional investigations, and demobilization.

4.6.1 Premobilization Activities

Before the start of survey activities, a walkthrough of Parcel G buildings will be completed to accomplish the following:

- Establish building access points and assess security requirements.
- Assess survey support needs such as power, lighting, ladders, or scaffolding.
- Verify the types of materials in each SU.
- Identify safety concerns and inaccessible or difficult-to-survey areas.
- Identify radiological protection and control requirements.
- Identify materials requiring removal or disposal, and areas requiring cleaning.
- Assess methods for marking survey scan lanes and static measurement locations.

Impacted areas that are deemed unsafe for access or surveys, such as the mezzanine of Building 411, will be posted, secured, and annotated in reports.

4.6.1.1 Training Requirements

Any required non-site-specific training required for field personnel will be performed before mobilization to the extent practical. Training requirements are outlined in **Section 6**.

Medical examinations, medical monitoring, and training will be conducted in accordance with the APP/SSHP and **Section 6** requirements.

In addition to health and safety-related training, other training may be required as necessary including but not limited to the following:

- Aerial Lift (for personnel working from aerial lifts)
- Fall Protection (for personnel working at heights greater than 5 feet)
- Equipment as required (e.g., fork lift, skid steer, loader, back hoe, excavator)

4.6.1.2 Permitting and Notification

Before initiation of field activities for the radiological investigations, the contractor will notify the Navy RPM, ROICC, and RASO and HPNS security as to the nature of the anticipated work. Any required permits to conduct the fieldwork will be obtained before mobilization.

The contractor will notify the California Department of Public Health at least 14 days before initiation of activities involving the Radioactive Material License.

4.6.1.3 Pre-construction Meeting

A pre-construction meeting will be held before mobilization of equipment and personnel. The purpose of the meeting will be to discuss project-specific topics, roles and responsibilities of project personnel, project schedule, health and safety concerns, and other topics that require discussions before field mobilization. Representatives of the following will attend the pre-construction meeting:

- Navy (RPM, RASO, ROICC, and others as applicable)
- Contractor (Project Manager, Site Construction Manager, Project QC Manager, PRSO, and SSHO)
- Subcontractors as appropriate

4.6.2 Mobilization Activities

Mobilization activities will include site preparation, movement of equipment and materials to the site, and orientation and training of field personnel.

At least 2 weeks before mobilization, the appropriate Navy personnel, including the Navy RPM, ROICC, and Caretaker Site Office, will be notified regarding the planned schedule for mobilization and site remediation activities. Upon receipt of the appropriate records and authorizations, field personnel, temporary facilities, and required construction materials will be mobilized to the site.

The temporary facilities will include restrooms, hand-washing stations, and one or more secure storage (Conex) boxes for short- and long-term storage of materials, if needed.

The applicable AHAs will be reviewed prior to starting work.

All equipment mobilized to the site will undergo baseline radioactivity surveys in accordance with **Section 6**. Surveys will include directs scans, static measurements, and wipe samples. Equipment that fails baseline surveying will not be removed from site immediately.

Loose, residual debris from past building occupation, investigations, vandalism, or asbestos and lead abatement will be removed for disposal and to prepare the buildings for cleaning. Cleaning will be sufficient to remove loose, surface material that may not be native to the building construction and may inhibit or damage survey instruments. Cleaning activities will be conducted consistent with the radiation protection procedures in **Section 6.4**. Dust control methods and air monitoring will be implemented, if warranted, as detailed in **Section 8.5**. Floors will be cleaned using ride-on floor scrubbers and vacuums. Walls and other surfaces will be cleaned as required during surveying. Wet areas will be dried using vacuums, blowers, or squeegees and may be delineated with spill containment booms if water infiltration is recurrent. Waste from debris removal and cleaning activities will be evaluated as described in **Section 6.4** and **Section 7**.

4.6.3 Building Investigation and Remediation Activities

Once all site preparation activities previously described are completed, building investigation and remediation activities will commence in the following general sequence:

- Mark SUs.
- Prepare instruments.
- Perform alpha-beta scanning in SUs and RBA and conduct preliminary data review.
- Perform alpha-beta systematic static and swipe measurements in SUs and RBA and conduct preliminary data review.
- Perform alpha-beta biased static and swipe measurements in SUs and conduct preliminary data review.
- Delineate and remediate residual contamination, if present.
- Evaluate and report data as described in **Section 5**.

4.6.3.1 Survey Unit Preparation

SUs will be durably marked prior to measurement activities to indicate SU boundaries, number, scan lanes and directions, and systematic measurement locations. Scan lane widths will be approximately 10 percent smaller than the detector’s active width, in the direction of scanning, to ensure overlapping coverage.

Upon receipt of survey instruments for the building investigations and completion of performance checks, background measurements will be obtained in the RBAs for each instrument and on each surface material type (e.g., concrete, metal, wood, and sheet rock) that is also present in the SUs. The background measurements will consist of at least 18 static measurements on each surface to match the number performed in each SU. The mean instrument- and material-specific background count rate will be used to update the instrument detection calculations and static count times in **Section 4.5.8**.

4.6.3.2 Survey Unit and Reference Background Area Alpha-Beta Scanning

Survey units will be scanned to detect alpha and beta emitters using average scan rates that ensure an alpha probability of detection of approximately 90 percent (**Sections 4.5.8.3 and 4.5.8.4**) where feasible and that the beta scan MDC (**Section 4.5.8.5**) is less than or equal to the RG_β for the building (**Section 4.3**). Scanning will cover a total area of each SU according to its classification. The total surface area of remaining, accessible impacted surfaces to be scanned will be 100 percent in Class 1 SUs, 50 percent in Class 2 SUs, and up to 10 percent in Class 3 SUs.

The scan rate for the RSCS SCM is entered using the SIMS and results in a fixed, motor-controlled scan rate. At least every 10 SUs of scanning, the RSCS SCM scan rate will be verified manually using the distance scanned and scan duration. The distance scanned is the linear distance, in centimeters, traveled by the detector during data acquisition. The scan duration is the total time, in seconds, of data acquisition. Dividing the distance scanned (cm) by the scan duration (seconds) gives an estimate of the average detector scan rate (cm/s) for that scanning period. Direct observation or review of the positional data from the RSCS SCM serve to verify that the detector was in constant motion during scanning. The scan rates for other planned instruments (e.g., Ludlum Model 43-37 and Ludlum Model 43-68) are manually controlled by the surveyor and will be verified manually in each SU by direct observation and measurement of the time elapsed while scanning a known distance.

While using a PSPC, scanning may traverse multiple SUs at once for efficiency, but alpha-beta scan data will be assigned to, and analyzed by, individual SUs. Areas inaccessible to a PSPC will be scanned using a gas-proportional detector with data logging functions. A DQA of the alpha-beta scan data (**Section 5.2**) will identify locations that exceed the applicable beta scan IL (**Section 4.5.8.2**) and, therefore, require further investigation (**Section 5.3**). Alpha-beta scan data will also be used to verify the assumptions for the relative shift and revise the number of static measurements for each SU, if necessary (**Section 4.4.1**).

4.6.3.3 Survey Unit Systematic Alpha-Beta Static Measurements

Static measurements will be performed at each systematic static location and will total 18 in each SU and the RBA, or the revised number determined in **Section 4.4.1**. Locations that pose safety concerns or obstructions will be relocated to the nearest accessible location and noted on the field measurement forms.

Each static measurement will be performed in scaler mode for a count duration sufficient to ensure that the alpha and beta static MDCs are equal to or less than the RG_α and RG_β for the building, respectively. A DQA of the static measurement data (**Section 5.2**) will identify locations that exceed the applicable alpha or beta static IL (**Section 4.5.8.6**) and, therefore, require further investigation (**Section 5.3**) or remediation.

4.6.3.4 Biased Alpha-Beta Static Measurements

Biased static measurements will be used to further investigate areas with potential elevated surface activity, as indicated by beta scan data exceeding the beta scan IL or systematic static data exceeding the applicable alpha or beta static IL. The survey meter will be operated in scaler mode and measurements will be made for the same count duration as that for the systematic static measurements.

4.6.3.5 Alpha-Beta Swipe Samples

Swipe samples will be taken at all locations of systematic and biased static measurements. They will be taken dry, using moderate pressure, over an area of approximately 100 cm^2. Swipe samples will be measured for gross alpha and beta activity using a Ludlum Model 3030 or equivalent. The surface activity on the sample will be compared to the total surface activity measured by the static measurement to assess the removable fraction of surface activity. This information will be used in any dose or risk assessment performed.

4.6.3.6 Assessment of Residual Materials and Equipment

Several buildings contain residual materials and equipment from past operations, such as piping, ventilation, shelving, or machinery, that will undergo radioactivity surveys in accordance with SOP RP-104, *Radiological Surveys*, and SOP RP-105, *Unrestricted Release Requirements* (**Appendix D**). These surveys may include a combination of surface scans and static measurements, swipe samples, and material samples. Where possible, sampling or survey points accessed during previous surveys will be used as a starting point. Surveys of impacted building material and equipment will be incorporated into the building SU. After data evaluation, disposition decisions, and subsequent investigation of the surfaces below the materials and equipment, will be coordinated with the Navy.

4.6.3.7 Decontamination and Release of Equipment and Tools

Decontamination of mobilized materials and equipment may be necessary at completion of fieldwork if radioactive materials above RGs are encountered. Numerous decontamination methods are available for use. If practical, manual decontamination methods should be used. Abrasive methods may be necessary if areas of fixed contamination are identified. Chemical decontamination can also be accomplished by using detergents for nonporous surfaces with contamination present. Chemicals should be selected for decontamination that will minimize the creation of mixed waste. Decontamination activities will be conducted using SOP RP-132, *Radiological Protective Clothing Selection, Monitoring, and Decontamination* (**Appendix D**).

4.6.3.8 Remediation of Contaminated Building Surfaces

Following the identification and characterization of contaminated building surfaces, remediation may be required so that residual radioactivity meets the Parcel G ROD RAO. Specific remediation or decontamination techniques selected will depend on contaminant, type of surface, and other site-specific factors. Types of decontamination that may be performed include concrete scarifying or scabbling, application of strippable surface coatings, and bulk removal of building components. Remediation will be conducted in building areas that exceed RGs and background. Confirmation measurements will be collected where remediation is performed to verify that contamination has been removed.

4.6.4 Demobilization

Demobilization will consist of surveying, decontaminating, and removing equipment and materials used during the investigations; cleaning and inspecting the project site; and removing temporary facilities. Survey of equipment and materials will be performed in accordance with **Section 6.6**, and decontamination will be performed in accordance with **Section 3.6.7.2**. Demobilization activities will also involve collection and disposal of contaminated materials, including decontamination water and disposable equipment for which decontamination is inappropriate (**Section 7**).

SECTION 5

Data Evaluation and Reporting

Data from the radiological investigation will be evaluated to determine whether the site conditions are compliant with the Parcel G ROD RAO. If the residual ROC concentrations are below the RGs in the Parcel G ROD or are shown to be NORM or anthropogenic background, then the site conditions are compliant with the Parcel G ROD RAO.

Radiological surveys will include scan measurements of accessible surfaces combined with collection and analysis of samples and static measurements on building interior surfaces. Scan measurements are used to identify potential areas of elevated radioactivity for investigation using biased samples and static measurements and are not used to directly demonstrate compliance with the Parcel G ROD RAO. Sample and static measurement results at systematic, random, and biased locations are used to evaluate compliance with the Parcel G ROD RAO. A separate compliance decision will be made for each ROC for each sample and static measurement.

In general, the following actions will occur during data evaluation and reporting:

- Scan data will be evaluated to identify potential areas of elevated activity for additional investigation, as follows:
  - Confirm that required scan surveys have been performed on accessible surfaces as described in **Section 3** for soil and **Section 4** for buildings.
  - Scan data will be verified as described in the SAP (**Appendix B**).
  - DQA will be performed on scan data as described in **Section 5.2**.
  - Potential areas of elevated activity will be identified as described in **Section 5.3.1**.
  - Potential areas of elevated activity will be investigated as described in **Section 5.3.2**.
- Soil sample and static measurement data will be evaluated to determine whether site conditions comply with the Parcel G ROD RAO, as follows:
  - Confirm that required soil samples have been collected from systematic and biased locations as described in **Section 3** and required building measurements have been performed as described in **Section 4**.
  - Confirm that samples have been submitted to the laboratory and backup samples have been archived in a secure area under chain-of-custody protocols.
  - Confirm that laboratory analyses have been performed as described in the SAP (**Appendix B**).
  - All analytical data will be validated by an independent third party.
  - DQA will be performed as described in **Section 5.2**.
  - Sample and direct measurement results will be compared to the corresponding RGs as described in **Section 5.4**.
  - Sample and direct measurement results will be compared to the appropriate RBA data from HPNS as described in **Section 5.5**.
  - Samples with gamma spectroscopy results that exceed the RG and the expected range of background for ^{226}Ra will be analyzed by alpha spectroscopy for uranium isotopes (^{238}U, ^{235}U, ^{234}U), thorium isotopes (^{232}Th, ^{230}Th, and ^{228}Th), and ^{226}Ra to evaluate the equilibrium status of

the uranium natural decay series to determine whether ^{226}Ra is NORM as described in **Section 5.6**.

- Results of the investigation will be documented as described in **Section 5.7**.

5.1 Data Quality Validation

Analytical data validation will be performed by an independent third party as described in the SAP (**Appendix B**). Data validation will be performed on all TU/SU data and all RBA data.

5.2 Data Quality Assessment

The DQA is a scientific and statistical evaluation that determines whether the survey data are the right type, quantity, and quality to support the survey objectives (USEPA, 2006). There are five steps in the DQA process:

1. Review the DQOs and survey design.
2. Conduct a preliminary data review.
3. Select the statistical test.
4. Verify the assumptions of the statistical test.
5. Draw conclusions from the data.

The effort expended during the DQA should be consistent with the graded approach used to develop the survey design. The DQA process will be applied to all SU data and all RBA data.

5.2.1 Review the Data Quality Objectives and Survey Design

The sampling design and data collection documentation will be reviewed for consistency with the DQOs. At a minimum, this review will include:

- Number of soil samples or measurements in each SU
- Location of soil samples and measurements
- Measurement technique (i.e., scan, static, sample, or swipe) and instrumentation
  - Measurement uncertainty
  - Detectability (critical level and MDC)
  - Quantifiability
- Statistical power

The purpose of the review should focus on identifying the information required to complete the evaluation of the data, the determination of whether the survey objectives were achieved will be completed during Step 5 of the DQA Process (see **Section 5.2.3**).

5.2.2 Conduct a Preliminary Data Review

A preliminary data review will be conducted to learn about the structure of the data by identifying patterns, relationships, or potential anomalies. The preliminary data review will include calculating statistical quantities, preparing posting plots of scan and sample data, preparing histograms of scan and sample data, preparing quantile-quantile (Q-Q) plots (sometimes referred to as normal probability plots) of scan and sample data, preparing box plots of scan and sample data, preparing retrospective power curves, and analysis of data distributions.

If additional data evaluation tools are used to support conclusions concerning compliance with the Parcel G ROD RAO, the report will provide a complete description of the evaluation performed and any assumptions used. For example, if a contour plot is provided to describe site conditions, the report would contain a description of the contouring technique used, a list of parameter values and assumptions used to prepare the contour plots, a copy of the contour plot, and an interpretation of the contour plot relative to compliance with the Parcel G ROD RAO.

5.2.2.1 Convert Survey Results

The RGs for soil (**Table 3-5**) are stated in units of pCi/g, and soil sample results from analytical laboratories will be reported in units of pCi/g, so no conversion will be necessary for soil sample data.

The RGs for buildings surfaces (**Tables 4-2 and 4-3**) are stated in units of dpm/100 cm^2; however, alpha and beta static measurement results will be reported in units of counts during a specified counting interval, while scan measurement results will be reported in units of cpm. Example ILs for alpha and beta scan measurements are provided in **Table 4-7** where the RGs have been converted into cpm using **Equation 4-2** and example total efficiencies from **Table 4-6**. Example ILs for alpha and beta static measurements are provided in **Table 4-9** where the RGs have been converted into counts using **Equation 4-8** and example total efficiencies from **Table 4-6**. Instrument-specific total efficiencies and material-specific backgrounds will be determined in the field, along with instrument-specific ILs corresponding with the RGs for alpha and beta static and scan measurements on building surfaces.

Once all the survey results and RGs are available in the same or comparable units, the evaluation of the data can continue.

5.2.2.2 Calculate Statistical Quantities

The mean, median, standard deviation, minimum, and maximum for each data set will be reported. Other statistical quantities that may be reported to describe individual data sets include percentiles (25th and 75th for interquartile range, 95th and 99th for upper bound estimates), skewness (a measure of deviation from normal), coefficient of variation, and total number of data points in the data set.

5.2.2.3 Prepare Posting Plots

Posting plots are maps on which measurement results are shown at the location where the measurement was performed. Posting plots will be prepared for scan survey data, and static and swipe data from biased, systematic, and random locations on building surfaces. Posting plots of soil sample locations may also be prepared for Phase 1 TUs, Phase 2 TUs, and surface soil SUs. Posting plots will be prepared for each SU but are not required for each RBA.

Posting plots are inspected to identify patterns or inconsistencies in the data, especially potential areas of elevated activity requiring additional investigation or spatial trends identifying survey data that are not independent, violating the assumptions of the statistical tests. Posting plots may be prepared using counts, count rates, concentrations, or normalized data (standard deviations or z-scores) allowing comparison of results from multiple detectors or different measurement methods. Posting plots are most useful when presented in the same units as the RGs or ILs being evaluated.

5.2.2.4 Prepare Histograms

Histograms, or frequency plots, are used to examine the general shape of a data distribution. Histograms will be prepared for scan survey data, static and smear survey data from systematic and random locations, and soil sample data from systematic locations for each SU and RBA. Biased survey data do not need to be included when preparing histograms; however, care should be taken when interpreting histograms that include data collected from biased locations. Histograms reveal obvious departures from symmetry, including skewness, bimodality, or significant outliers.

5.2.2.5 Prepare Q-Q Plots

Q-Q plots compare a data distribution to an assumed normal distribution. Q-Q plots will be prepared for scan survey data, static and smear survey data from systematic and random locations, and soil sample data from systematic locations for each SU and RBA. Biased survey data do not need to be included when preparing Q-Q plots; however, care should be taken when interpreting Q-Q plots that include data collected from biased locations.

Background data usually approximate a normal distribution, so comparing SU data to a normal distribution is one technique in comparing survey data to background. Data from a normal distribution appear as a straight line on a Q-Q plot, so deviations from a straight line indicate potential deviations from a normal distribution, or potential deviations from background. Normal probability plots from different data sets, such as a SU and an RBA or adjacent SUs, can be shown on the same graph to allow for direct comparisons between multiple data sets.

5.2.2.6 Prepare Box Plots

Box plots are a non-parametric graphical depiction of numerical data based primarily on quartiles (25th, 50th, and 75th percentiles). Box plots may include whiskers showing extreme values, usually the minimum and maximum. Box plots may also show outliers as individual points. The ends of the whiskers and selection criteria for outliers are not standardized and may represent different values depending on the underlying assumptions.

Box plots provide visual estimates of dispersion and skewness for a data set including the range, interquartile range, and median. Box plots from different data sets, such as an SU and a RBA or adjacent SUs, can be shown on the same graph to allow for direct comparisons between multiple data sets.

5.2.2.7 Prepare Retrospective Power Curves

A retrospective power curve provides an evaluation of the survey design and is used to demonstrate enough data were collected to support decisions regarding the radiological status of the SU. Retrospective power curves will be prepared for static and smear survey data from systematic and random locations, and soil sample data from systematic locations for each SU. Biased survey data will not be included when preparing retrospective power curves. The retrospective power curve is compared with the DQOs (**Section 3.1** and **Section 4.1**) and the Type II decision error rates from Section 4.4.6 of the Basewide Radiological Management Plan (TtEC, 2012), to evaluate whether a sufficient number of samples was collected.

No statistical tests are required for individual data sets because compliance with the Parcel G ROD RAO is based on point-by-point comparisons. Because the number of measurements per SU was determined assuming that a statistical test would be performed, the retrospective power curve assists in determining whether the survey design was adequate and is not directly related to compliance decisions.

5.2.2.8 Analysis of Data Distributions

The distribution of data within a data set can provide important information during data evaluation. Determining the type of distribution may be important for selecting additional evaluation tools to answer specific questions about individual data sets. The analysis of data distributions for this investigation may be used primarily for establishing MLE values for RBA data sets (**Appendix C**).

Environmental data are most often associated with three distributions: normal, lognormal, or gamma. Statistical tests to identify a distribution have a null hypothesis that the data set comes from the distribution being tested. This means there must be sufficient evidence showing that the data do not follow a specific distribution before the initial assumption is rejected. For this reason, it is not unusual for a data set to be associated with more than one type of distribution. Moreover, negative values in a data set cannot provide results for analyzing lognormal or gamma distributions.

Individual data sets will be analyzed to determine whether the data appear to follow a normal, lognormal, or gamma distribution at a 5 percent significance level using software such as ProUCL. Data sets that do not follow at least one of these distributions will be identified as not following any known distribution and will be evaluated using nonparametric tools and tests.

5.2.3 Draw Conclusions from the Data

Figures 3-2 and **4-9** present an overview of how decisions for soil and building data, respectively, are combined to draw a conclusion on compliance with the Parcel G ROD RAO. Each sample and static measurement result will be compared to the corresponding RG. If all residual ROC concentrations are less than or equal to the corresponding RG, then site conditions comply with the Parcel G ROD RAO.

Sample and measurement data will be compared to appropriate RBA data from HPNS, and multiple lines of evidence will be evaluated to determine whether site conditions are consistent with NORM or anthropogenic background. The data evaluation may include population-to-population comparisons, use of a MLE or BTV, graphical comparisons, and comparison with regional background levels. If all residual ROC concentrations are determined to be consistent with NORM or anthropogenic background, site conditions comply with the Parcel G ROD RAO.

Each ^{226}Ra gamma spectroscopy result exceeding the ^{226}Ra RG and outside the expected range of background will be compared to concentrations of other radionuclides in the uranium natural decay series from the same sample. If the concentrations of radionuclides in the uranium natural decay series are consistent with the assumption of secular equilibrium, then the ^{226}Ra concentration is NORM, and site conditions comply with the Parcel G ROD RAO.

If the investigation results demonstrate that there are no exceedances determined from a point-by-point comparison with the statistically-based RGs[9] at agreed upon statistical confidence levels, or that residual ROC concentrations are NORM or anthropogenic background, then a RACR will be developed.

If the investigation results demonstrate exceedances of the RGs determined from a point-by-point comparison with the statistically-based[9] RGs at agreed upon statistical confidence levels and are not shown to be NORM or anthropogenic background, remediation will be conducted, followed by a RACR. The RACR will describe the results of the investigation, explain remediation performed, compare the distribution of data from the sites with applicable reference area data, and provide a demonstration that site conditions are compliant with the Parcel G ROD RAO through the use of multiple lines of evidence including application of statistical testing with agreed upon statistical confidence levels on the background data.

5.3 Investigation of Potential Areas of Elevated Activity

The investigation of potential areas of elevated activity consists of comparing each measurement result from every SU with the ILs discussed in **Section 3.3.1** for soil, **Section 4.5.8.2** for building scans, and **Section 4.5.8.6** for building static measurements. In general, the ILs are consistent with the RG values. This investigation is performed for all measurement results; scans, static measurements, and samples, at systematic, random, and biased locations. The investigation of potential areas of elevated activity ensures that unusually high measurement and sample results will receive proper attention, and any area having the potential for significant contributions to total dose will be identified.

5.3.1 Identify Potential Areas of Elevated Activity

Scan data, measurement data, and sample data will be evaluated to identify statistical and spatial anomalies indicating potential areas of elevated activity. All scan data will be compared directly to RGs or ILs. Posting plots will be used to identify trends and patterns in the scan data to help in identifying potential areas of elevated activity and support defining the areal extent of potential areas of elevated

[9] The RGs are statistically based because they are increments above a statistical background.

activity. Histograms and Q-Q plots will be used to identify significant outliers and evidence of multiple distributions to identify potential areas of elevated activity. Any sample or measurement exceeding a ROC-specific RG will be investigated as a potential area of elevated activity. In addition, SU areas with multiple lines of evidence indicating a potential increase in localized activity based on posting plots, histograms, and Q-Q plots of scan, static measurement, or sample data will be investigated as a potential area of elevated activity.

If direct measurement or sample results exceed the RG or IL for a specific ROC for locations not identified by scan survey, the scan survey technique will be reviewed and investigated to determine whether the scan survey was implemented correctly and whether the scan methodology met the survey objectives.

5.3.2 Investigate Potential Areas of Elevated Activity

The objective of investigating potential areas of elevated activity is to characterize the ROCs present and the size, or extent, of all areas of elevated activity. To accomplish this objective, a minimum of one potential area of elevated activity will be investigated in every SU. If no potential areas of elevated activity are identified in a TU/SU based on **Section 5.3.1**, the location of the maximum scan result will be identified as a potential area of elevated activity.

The first step in investigating potential areas of elevated activity is to confirm the measurement or sample results that indicated the potential area of elevated activity. For alpha and beta scans, this may be accomplished by pausing during scanning to collect additional information, or it may require returning to a location to perform a biased static measurement. For gamma scans this may involve rescanning the area surrounding the potential elevated reading, sifting through near surface soil for a discrete source of activity (e.g., deck marker), or collecting a biased soil sample for analysis. The selection of the confirmatory action will depend on the initial results and the decision on whether the original results are confirmed. In general, minimal information is acceptable when deciding to continue with the investigation of a potential area of elevated activity. In most cases, at least one measurement or sample result documenting the lack of elevated activity will be required to support a decision to terminate the investigation of a potential area of elevated activity.

Once the presence of an area of elevated activity has been confirmed, the ROCs present will be identified. In most cases the identification of ROCs can be accomplished using existing data. For building surfaces, it is sufficient to identify the elevated activity as alpha, beta, or a combination of alpha and beta radiation. For soil samples, it is generally necessary to identify the radionuclide based on laboratory analysis.

The final step in investigating areas of confirmed elevated activity is determining the area, or extent, of the elevated results. The identification of the ROCs present will assist in determining whether additional data are required to determine the extent of elevated activity, and the number and type of measurements or samples that will be used for that determination. For building surfaces, the posting plot of the scan data is generally all that is needed to determine the extent of elevated readings. The determination may be accomplished similarly for soil areas when the ROC is ^{226}Ra and the elevated activity is readily detected by scan surveys. Determining the extent of elevated activity for ROCs without a significant gamma emission, such as ^{90}Sr and ^{239}Pu, will require collecting additional soil samples or establishing a correlation between the difficult-to-detect ROC and ^{226}Ra. Even when a correlation can be determined, the scan survey objectives will need to be reviewed and adjusted to account for detecting ^{226}Ra at lower activity levels. If the elevated activity is associated with ^{90}Sr or ^{239}Pu results significantly above background, a Field Change Request will be initiated to document the characterization of any potential areas of elevated activity. The results of the investigation should identify an area of elevated activity bounded by measurements or sample results below the RGs or ILs.

If all alpha or beta static measurement or ROC-specific soil sample analysis result are less than the RGs or ILs, compliance with the Parcel G ROD RAO is achieved.

5.4 Comparison to RG Values

The Parcel G ROD establishes RGs for soil and building surfaces. These RG values are provided in **Table 3-5** for soils and **Tables 4-2** and **4-3** for building surfaces.

Analytical data from systematic and biased surface and subsurface soil sample results will be compared directly with the RGs listed in **Table 3-5**. Each soil sample will have gamma spectroscopy data for ^{137}Cs (reported from its 661-keV peak) and ^{226}Ra (reported using the 609-keV gamma emission from ^{214}Bi following a 21-day ingrowth period). For all soil TUs and SUs, 10 percent of samples will have analysis for ^{90}Sr performed. In addition, a minimum of 10 percent of randomly selected systematic soil samples will be analyzed by alpha spectroscopy for ^{239}Pu at the Former Building 317/364/365 Site. These analytical results will be compared directly with the RGs listed in **Table 3-5** to determine compliance with the Parcel G ROD RAO.

^{137}Cs is considered to be the indicator for all fission product radionuclides associated with NRDL activities. The limited number of systematic samples analyzed for ^{90}Sr and ^{239}Pu will serve to supplement the investigation. Sample results above the ^{137}Cs RG will trigger additional analyses in the same sample for ^{90}Sr or ^{239}Pu. The results of these additional analyses will be compared directly with the corresponding RG value for ^{137}Cs, ^{90}Sr, and ^{239}Pu. Based on the inability to perform gamma scanning for these radionuclides at the RG, demonstrating compliance with the Parcel G ROD RAO will be based on soil sample analytical results.

The RGs for building surveys are listed in **Table 4-2**. Static measurement results will be provided for total alpha and total beta activity and are not radionuclide-specific. Therefore, the lowest RG values for alpha and beta emitting ROCs will be selected and are listed in **Table 4-3**. Total alpha and total beta results will be corrected for material-specific background and reported as net activity above the mean activity for that material from the RBA representing background for a specific building, on a specific material, using a specific detector. The net total activity will be compared directly with the corresponding RG.

If all sample and direct measurement results are less than or equal to the corresponding RG, then the site conditions are compliant with the Parcel G ROD RAO, and a RACR can be prepared as described in **Section 5.7**.

5.5 Comparison to Background

Sample and static measurement data shown to be NORM or anthropogenic background comply with the Parcel G ROD RAO, even if the results exceed the corresponding RG value. In addition, to address California Department of Public Health requirements for radiological release specified in California Code of Regulations Title 17, Section 30256, a comparison of site data with background will be performed.

RBA data sets for soil will be developed as described in the Soil RBA Work Plan (**Appendix C**) or selected from existing RBA data sets determined to be representative of soil at HPNS. RBA data sets for building surfaces will be developed as described in **Section 4.4.2** to provide building-specific, material-specific, and instrument-specific RBA data. Final selection of RBA data sets will be reviewed by the Navy, USEPA, and the State of California.

The comparison of site data with background may include, but is not limited to, the following:

- **Population-to-population comparisons.** Site data sets may be compared with RBA data using parametric or nonparametric tests, depending on the distributions of the data. Following the performance of any population test, the underlying assumptions of the test will be verified.
- **Use of an MLE or BTV.** A point-by-point comparison of site data with the MLE or BTV may be performed if RBA data allow for calculation of those values. MLE values will be calculated using USEPA's ProUCL software.

- **Graphical comparisons.** Graphical representations of site and RBA data may be useful in visually comparing two or more data sets. Typical graphical tools include histograms, box-and-whisker plots, and probability plots.
- **Comparison with regional background levels**. As noted in **Section 5.5**, much of HPNS was constructed using fill materials from offsite sources. As such, soil conditions at the site are heterogeneous, and the onsite RBAs may not accurately capture background levels of ROCs for all soil types that may be present at HPNS. Where appropriate, available RBA data from other sources may be used for comparison with site data.

If all residual ROC concentrations are consistent with NORM or anthropogenic background, site conditions comply with the Parcel G ROD RAO. If any ^{226}Ra gamma spectroscopy results for soil exceed the RG and the expected range of NORM concentrations, the equilibrium status of the uranium natural decay series will be evaluated for the sample as described in **Section 5.6**.

5.6 Determine Equilibrium Status

The RBA data set for ^{226}Ra and other naturally occurring ROCs will be selected to represent as much of the soil at HPNS as practical. However, the history of HPNS shows that a wide variety of fill materials have been used as part of construction and maintenance activities over the life of the site. These fill materials may have a range of naturally occurring radioactivity, so an incorrect identification of fill material could result, with higher levels of NORM being identified as contamination. To avoid this situation, additional evaluation may be performed for samples in which the ^{226}Ra gamma spectroscopy result exceeds the RG and the expected range of background, but the sample could still indicate association with NORM instead of contamination.

The uranium natural decay series is one of the primordial natural decay series that are collectively referred to as NORM. The members of the uranium natural decay series are present in background at concentrations that are approximately equal, a situation referred to as secular equilibrium. Secular equilibrium for the uranium natural decay series is established over hundreds of thousands of years. Concentrations of ^{226}Ra higher than the concentrations of other members of the uranium natural decay series may indicate contamination, while ^{226}Ra concentrations consistent with other members of the series indicate natural background.

Determining the equilibrium status of the uranium natural decay series requires analyzing a sample for multiple radionuclides from the series using the same or comparable analytical techniques. Observed differences in concentrations result primarily from differences in concentrations, and the uncertainty is primarily associated with the analysis.

Radionuclides from the uranium natural decay series with ^{226}Ra as a decay product (i.e., ^{238}U, ^{234}U, and ^{230}Th) will be analyzed by alpha spectroscopy, along with ^{226}Ra. It is not necessary to analyze for the decay products of ^{226}Ra because these radionuclides re-establish secular equilibrium with ^{226}Ra over a period of several weeks. In addition, most of the ^{226}Ra decay products are not readily analyzed by alpha spectroscopy. If practical, the analyses will be performed using the same sample aliquot to reduce sampling uncertainty. The results of the four analyses will be compared. If the ^{226}Ra result is similar to the results for the other radionuclides, the ^{226}Ra activity is NORM and complies with the Parcel G ROD RAO, and the equilibrium determination will be documented in the RACR. If the ^{226}Ra result is significantly greater than the results for the other radionuclides and exceeds the RG, the elevated ^{226}Ra level may be attributed to site contamination, and remediation may be required.

5.7 Reporting

Results of radiological investigations for buildings and TUs/SUs complying with the Parcel G ROD RAO will be documented in a RACR, and the buildings and TUs/SUs will be recommended for unrestricted radiological release. The RACR will describe the results of the investigation, provide visualizations of spatially correlated data, explain remediation performed, compare the distribution of data from the sites with applicable reference area data, and provide a demonstration that site conditions are compliant with the Parcel G ROD RAO. The final status survey results, including a comparison to background and discussion of remedial activities performed as part of the investigation, will be included as an attachment to the RACR.

SECTION 6

Radioactive Materials Management and Control

Project requirements, including personnel roles and responsibilities, required training, and health and safety protocols are presented in this section. This section was prepared based on CH2M and their subcontractor, Perma-Fix, leading and conducting the field activities presented in this work plan and should be amended for contractor-specific information, as needed. **Appendix D** contains contractor-specific information, including the Radioactive Material License, SOPs, Organizational Chart, and Radiation Protection Plan. A separate APP/SSHP will be prepared to outline the health and safety requirements and procedures for the work included in this work plan.

6.1 Project Roles and Responsibilities

The personnel responsible for the execution of site activities and program oversight is presented in the Organization Chart in **Appendix D**. The Field Team Leader is responsible for overseeing all field activities for this project. The Field Team Leader will serve as the primary point of contact for scheduling and field-related issues. The Radiation Safety Officer (RSO) has overall responsibility for ensuring that fieldwork is conducted by trained staff in accordance with the Radioactive Material License and applicable plans and procedures.

The RSO will be supported by radiation protection staff to implement the requirements of the licensed SOPs and for conducting radiological data collection in accordance with **Sections 3** and **4** of this work plan.

6.2 Licensing and Jurisdiction

The Radioactive Material License is State of California Radioactive Material License 8188-01 (dated November 15, 2017). The license is attached to this work plan in **Appendix D**. Under 10 *Code of Federal Regulations* (CFR) 150.20, Perma-Fix holds a general license to conduct these licensed activities in areas of exclusive federal jurisdiction within the State of California. Authorization will be required from California to work in certain parcels at HPNS. Authorization will be requested and approved before the start of field operations. **Figure 6-1** details the location of the specific parcels that are under exclusive federal jurisdiction and will require authorization. Perma-Fix will request reciprocity from the NRC, using NRC Form 241, to utilize Perma-Fix's State of California Radioactive Material License in areas under NRC jurisdiction. The NRC requires notification a minimum of 3 days prior to beginning licensed activities.

The following are State requirements:

- Under the Radioactive Material License (8188-01) Section 16, Perma-Fix will submit an appropriate notification to the State of California a minimum of 14 days before the start of work.
- Under the Radioactive Material License (8188-01) Section 17, Perma-Fix will obtain an appropriate agreement between Perma-Fix and the Navy. This agreement will be included in the Section 16 submittal.

A Memorandum of Understanding (MOU) for the site has been established and was updated on December 2, 2016 (**Appendix E**). This MOU supersedes all previous MOUs.

6.3 Radiological Health and Safety

Fieldwork will be conducted in accordance with Perma-Fix's State of California Radioactive Material License and associated SOPs. A list the field radiological SOPs that provide the instructions for conducting field activities involving exposure to radiation and radioactive materials and copies of the SOPs are provided in **Appendix D**.

Prerequisites for the initiation of survey activities include review of this work plan, radiological evaluation of the designated work areas, and identification of potential safety concerns. Dose rate, contamination, and air monitoring, including initial baseline sampling to determine radiological background conditions, will be performed as necessary and in accordance with this work plan and the supporting procedural documents, including the SOPs in **Appendix D**. Radiation Work Permits (RWPs) will be prepared in accordance with SOP RP-103, *Radiation Work Permits Preparation and Use.* RWPs will be used to govern radiological health and safety. Personal protective equipment (PPE) levels will be assigned or modified, according to this work plan and APP/SSHP, and included in SOP RP-132, *Radiological Protective Clothing Selection, Monitoring, and Decontamination,* such that they are protective of health and safety based on radiological considerations and physical and chemical safety issues. Radiological personnel will prepare, approve, and record monitoring records in accordance with SOP RP-114, *Control of Radiation Protection Records*.

Key radiological personnel are expected to have the requisite skills necessary to perform these functions. The key radiological personnel include the following:

- License RSO
- PRSO
- Project Manager for Perma-Fix
- Radiation Protection Supervisor
- RCTs

Roles may be combined as described in this work plan. Key personnel will be approved in advance by the project manager or field lead.

6.4 Radiation Protection

Appendix D contains the Radiation Protection Plan, which includes key Perma-Fix Radiation Protection Program procedures. The Radiation Protection Plan details requirements for activities conducted under the California Radioactive Material License and describes radiation safety practices to be applied in the field and referenced in the APP/SSHP. The Radiation Protection Plan covers project activities that involve the use or handling of licensed by-product, source, or special nuclear material (hereinafter referred to as radioactive material); tasks with the potential for radioactive material to be present based on available data and historical records; and work in posted RCAs.

6.4.1 Radiological Postings

Radiological postings are used to delineate the RCAs necessary to conduct investigation activities. Radiological posting requirements are found in SOP RP-102, *Radiological Postings* (**Appendix D**).

6.4.2 Internal and External Exposure Control and Monitoring

Based on review of historical data, radiation doses are not expected to exceed 100 millirems per year (annual public dose allotment) for any project personnel. Although worker doses are expected to be a small fraction of the annual limits, external dose rates and cumulative doses and internal doses, via airborne concentration measurements will be monitored to ensure that worker doses are maintained as low as reasonably achievable (ALARA). The dosimetry requirements are contained in SOP RP-112, *Dosimetry Issue*. The expectation is that all personnel entering the controlled area except untrained, escorted individuals as described in **Section 6.4.3** will be assigned an external monitoring device such as a thermoluminescent dosimeter. Untrained, escorted personnel entries will be logged such that the escort thermoluminescent dosimeter badge results can be used as the monitoring results for that individual if a question arises as to the possible external dose that individual received. Periodic external dose rate measurements will be taken before and during intrusive activities in accordance with SOP RP-104, *Radiological Surveys* (**Appendix D**), to ensure that worker exposures are maintained ALARA.

6.4.3 Radiological Access Control

Access control is necessary to provide a consistent methodology for controlling the access of personnel, equipment, and vehicles into radiological areas. Access control points further control the release of the materials, tools, and equipment from radiological areas. Access control requirements are found in SOP RP-101, *Access Control* (**Appendix D**). It is anticipated that areas targeted for investigation as part of this plan, including the soil sorting area or RSYs will be established as RCAs.

Personnel and equipment exiting the boundary of an RCA will be surveyed to ensure that their clothing, equipment, and vehicles do not leave the site with contamination.

A RWP is an administrative mechanism used to establish radiological controls for intended work activities. The RWP will provide information to workers on area radiological conditions and entry requirements including PPE. The following summarizes the RWP process for this project:

- RWP creation will be done by the License RSO or designee.
- RWPs will be approved by the License RSO or designee.
- Expected levels of contamination and external exposure rates will be listed in the RWP.
- Current and expected radiological conditions will be listed in the RWP.
- PPE and monitoring requirements will be specified in the RWP.
- Special monitoring instructions, hold points, or action levels may be listed as a part of the RWP requirements.
- RWP approval duration will be for the expected length of the project or until radiological conditions change and a revision is needed.
- Where radiological conditions change such that PPE or monitoring requirements must change, the work will be suspended until a new or revised RWP containing the new RWP requirements is issued.
- Personnel working in the area covered by the RWP will be briefed on the RWP requirements and sign an acknowledgment that they have received and understand the briefing.

RWP requirements are found in SOP RP-103, *Radiation Work Permits Preparation and Use* (**Appendix D**).

6.4.4 Personal Protective Equipment

PPE will be selected based on the specific hazard and will comply with the APP/SSHP, the RWP, and the AHA specific to the task being performed. Based on historical information, the planned investigation activities are not expected to encounter or generate removable or airborne radioactivity. Therefore, it is expected that fieldwork PPE will consist of wearing Level D PPE and will include the following:

- Long pants
- High visibility outer layer
- Safety-toed boots
- Hard hat
- Work gloves

- Eye protection

If the field conditions exceed action levels for additional response (detailed in Perma-Fix procedures SOP RP-101, *Access Control*; SOP RP-102, *Radiological Postings*; and SOP RP-103, *Radiation Work Permits Preparation and Use*) (**Appendix D**), PPE may be upgraded as necessary.

6.4.5 Instrumentation

Instruments to be used for worker protection and monitoring will include dose and exposure rate instruments, alpha-beta dual phosphor surface contamination detectors, handheld 2-inch by 2-inch NaI detectors for gross gamma investigations, and a dual phosphor alpha-beta bench top counter for analysis of surface swipe samples and air samples. Instruments will be operated in accordance with applicable instrument-specific SOPs.

All counting systems and instruments will be calibrated with a National Institute of Standards and Technology-traceable source at intervals not exceeding 12 months, or as recommended by the manufacturer. The source used will be appropriate for the type and the energy of the radiation to be detected. All calibrations will be documented and include the source data.

The minimum training requirements for personnel working in the field at HPNS are provided in the following sections.

6.4.6 Radiological Training

Radiological training includes the following modules in accordance with SOP RP-115, *Radiation Worker Training* (**Appendix D**):

- General Employee Radiological Training
- Radiological Worker Training and Certification
- RCT Training and Certification

Visitors and escorted persons must receive a site briefing and will be assigned to a qualified radiation worker or RCT when in a posted RCA.

6.4.7 Health and Safety Training

Health and safety training may include, but is not limited to, the following:

- Occupational Safety and Health Administration (OSHA) 40-hour Hazardous Waste Operations and Emergency Response (Hazardous Waste Operations and Emergency Response [HAZWOPER]) training
- OSHA 8-hour HAZWOPER refresher training
- OSHA 8-hour HAZWOPER supervisor training
- OSHA-required On the Job training
- Site- or task-specific AHA training
- Basic first aid training
- Cardiopulmonary resuscitation training

6.5 Radiological Support Surveys

Personnel, equipment, material, and area surveys will be performed in accordance with this work plan and appendixes. If survey results indicate levels of surface contamination, appropriate decontamination methods will be performed in accordance with applicable SOPs (**Appendix D**).

6.5.1 Personnel Surveys

Personnel surveys will be conducted in accordance with SOP RP-104, *Radiological Surveys* (**Appendix D**). Personnel surveys are used to ensure that individuals leaving a radiological area are free of contamination. Hands and feet "frisks" or scans with dual alpha-beta scintillators will be required when individuals exit RCAs.

Scanning will be performed in the alpha plus beta mode of the instrument because of the potential presence of ^{90}Sr, a pure beta emitter, and the fact that there are beta emissions from progeny in the radium decay chain that can be used as a surrogate for potential radium contamination. Where contamination is found or suspected, the PRSO will be contacted and will provide further technical direction for any personnel/clothing decontamination that may be needed.

6.6 Equipment Surveys

6.6.1 Swipe Samples

Swipe sampling will be performed to assess the presence of radioactive contamination that is readily removed from a surface. Swipe samples will be taken to evaluate the presence of removable alpha and beta activity. The procedures for collecting swipe samples are discussed in SOP RP-104, *Radiological Surveys* (**Appendix D**).

6.6.2 Exposure Rate Surveys (Dose Rates)

Exposure rate surveys are performed to measure ambient gamma radiation levels. Exposure rate surveys will be performed prior to and periodically during intrusive activities to confirm exposure levels relative to RWP requirements.

6.6.3 Equipment Baseline and Unconditional Release Surveys

Equipment mobilized and demobilized from the site will undergo radioactivity surveys in accordance with RP-104 *Radiological Surveys* and RP-105 *Unconditional Release Requirements* (**Appendix D**). Baseline and Release surveys may include a combination of surface scans and static measurements using dual alpha-beta scintillators and swipe samples.

6.7 Documentation and Records Management

The purpose of this section is to define standards for the maintenance and retention of radiological records. Radiological records provide historical data, document radiological conditions, and record personnel exposure. Field documentation requirements are outlined in the SAP (**Appendix B**) and SOP RP-114, *Control of Radiation Protection Records* (**Appendix D**).

Radiological surveys will be performed and documented in accordance with SOP RP-106, *Survey Documentation and Review* (**Appendix D**). Sample collection, field measurements, and laboratory data will be recorded electronically to the extent practicable. Electronically recorded data and information will be backed up to a SharePoint site or equivalent on a nightly basis, or as reasonably practical. Data and information recorded on paper will be recorded using indelible ink. Both electronic and paper records of field-generated data will be reviewed by the PRSO or a designee knowledgeable in the measurement method for completeness, consistency, and accuracy. Data manually transposed to paper from electronic data collection devices will be compared to the original data sets to ensure consistency and to resolve noted discrepancies. Electronic copies of original electronic data sets will be preserved on a nonmagnetic retrievable data storage device. No data reduction, filtering, or modification will be performed on the original electronic versions of data sets.

6.7.1 Documentation Quality Standards

Records will be legible and completed with an indelible ink that provides reproducible and legible copies. Records will be dated and contain a verifiable signature of the originator. Errors that may be identified will be corrected by marking a single line through the error and by initialing and dating the correction.

Radiological records will not be corrected using an opaque substance. Shorthand or nonstandardized terms may not be used.

To ensure traceability, each record will clearly indicate the following:

- Name of the project
- Specific location
- Function and process
- Date
- Document number (if applicable)

The quantities used in records will be clearly indicated in standard units (e.g., curie, radiation absorbed dose [rad], roentgen equivalent man [rem], dpm, becquerel), including multiples and subdivisions of these units.

6.7.2 Laboratory Records

Survey and laboratory data assessment records will be prepared as indicated in the contractor's QA/QC Plan.

6.7.3 Record Retention

Records resulting from implementation of this work plan will be retained as outlined in the SAP (**Appendix B**).

SECTION 7

Waste Management Plan

This section describes the type of waste expected to be generated and the management, transport, and disposal of the material.

7.1 Project Waste Descriptions

Waste generated during this investigation may be radiological in nature. It is anticipated that the following waste streams will be generated and managed as indicated in **Table 7-1**. Consult the project Environmental Manager for waste streams that are not specifically identified.

Table 7-1. Waste Management

Waste Stream	Source/Process	Staged in	Staged at	Final Disposition
Radiological Wastes (LLRW)				
Soil or sediment	Soil sampling/building cleaning activities	In accordance with 40 CFR 173, Subpart I	Navy approved location	Offsite disposal
Concrete and asphalt	Excavation/sampling	In accordance with 40 CFR 173, Subpart I	Navy approved location	Offsite disposal
Potential radiological commodities (e.g., deck markers)	Excavation/sampling	In accordance with 40 CFR 173, Subpart I	Navy approved location	Offsite disposal
Debris including PPE, plastic sheeting, disposable sampling equipment	Investigation activities involving disposable equipment	Include with soil/concrete	Navy approved location	Offsite disposal
Water from decontamination or dewatering	Excavation/sampling/equipment decontamination/building cleaning activities	In accordance with 40 CFR 173, Subpart I	Navy approved location	Offsite disposal
Nonradiological Wastes (Non-LLRW)				
Soil, sediment, concrete, or asphalt	Soil sampling/building cleaning activities	DOT specification drums or containers, IBC, or roll-off type bins	Navy approved location	Offsite disposal
Debris including PPE, plastic sheeting, disposable sampling equipment	Investigation activities involving disposable equipment	Include with soil	Navy approved location	Offsite disposal
Water from decontamination or dewatering	Excavation/sampling/equipment decontamination/building cleaning activities	DOT specification drums or containers	Navy approved location	Offsite disposal

Table 7-1. Waste Management

Waste Stream	Source/Process	Staged in	Staged at	Final Disposition
Miscellaneous trash that has not contacted contaminated media	Investigation activities	Black nontranslucent trash bags	Removed daily	Dumpsters at the Base

Notes:

DOT = Department of Transportation

The following sections address specific control and management practices for radiological waste (LLRW) and nonradiological waste (non-LLRW). Waste determined to be non-LLRW will be transported and disposed of by the contractor. LLRW will be transferred to the Navy's radiological waste contractor, and disposed of offsite, in accordance with the MOU (**Appendix E**).

7.2 Radiological Waste Management

Waste materials deemed to be radioactive waste will be managed in accordance with the *Radiation Protection Workplan* and applicable license procedures, including SOP RP-111, *Radioactive Materials Control and Waste Management Program* (**Appendix D**).

7.2.1 Waste Classification

Accumulated waste deemed to be radioactive waste will be classified as LLRW based on 49 CFR, basewide requirements, or disposal facility requirements. Waste characteristics, including the radionuclides present and their associated specific activities, will be measured by an available standardized test method in accordance with the SAP (**Appendix B**), such as gamma spectroscopy, strontium analysis, or alpha spectrometry.

7.2.2 Waste Accumulation and Storage

Soil, debris, water, and materials classified as LLRW may be generated during sampling. When classified as LLRW, these wastes may be placed in containers provided by Navy (55-gallon drums, super sacks, or equivalent). When filled, LLRW containers will be transferred to the custody and control of the Navy's radiological waste contractor, who will provide brokerage services including waste characterization sampling, transportation, and disposal in accordance with federal regulations and disposal facility requirements. Containers will be properly lined and an absorbent will be used if it is considered necessary. Containers will be radiologically surveyed when filled with material. Each container will be properly inventoried and labeled. Inventories will include material description and isotopic identification, and hazardous components, if appropriate. The contents of each container will be recorded in the field logbook, and each container will be assigned a unique identification number.

Containers will be stored in a designated and posted radioactive material storage area under the authority of the Navy's radiological waste contractor's California Radioactive Material License. Storage areas may be at the site where the waste originated or another location as directed by the Navy. Containers will be secured to prevent unauthorized access to their contents. Once filled, containers will be surveyed, and surface radiation dose rate measurements will be collected.

7.2.3 Labeling and Posting of Containers Containing Radioactive Waste

Each waste container containing LLRW will be labeled. The activity contained in each waste container will be reported in pCi/g, and maximum contact radiation levels will be measured in milliroentgens per hour. Following the surveying and labeling, the waste container will be placed in a designated and posted radioactive area. The container area will be posted with a “Caution – Radioactive Materials Area” posting. An inventory of contents with radionuclide and specific activity (if available) will be maintained by the contractor until the custody of the material is transferred to the Navy’s radiological waste contractor.

7.2.4 Waste Accumulation Areas

The contractor working on this project will implement, at a minimum, the following requirements for radioactive waste stored onsite within a designated radioactive materials area:

- Industry standard posting and barrier materials will be displayed with wording that includes the following, “Caution – Radioactive Materials Area,” at each radioactive waste storage area sufficient to be seen from any approach. The signs will be legible and clearly conspicuous for outdoor and indoor locations.
- Aisle space will be maintained to allow for the unobstructed movement of personnel, fire-control equipment, spill-control equipment, and decontamination equipment to any facility operation area, in the event of an emergency, unless aisle space is not needed for any of these purposes.
- The areas will be secured to prevent unauthorized access to the material.
- The following emergency equipment will be located or available to personnel during radioactive waste management activities at each accumulation area:
  - A device, such as a telephone or a handheld two-way radio, capable of summoning emergency assistance (adjacent areas with personnel who have communication devices or areas with fixed devices that personnel can access quickly are sufficient)
  - Portable fire extinguishers, fire-control equipment, spill-control equipment, and decontamination equipment

Filled containers generated during performance of work will be stored in a material storage location until the contained material can be characterized and appropriately classified. Depending on the characterization results, the material may be moved to another storage location, transported and disposed of offsite, or reused as backfill.

7.2.5 Inspection of Waste Accumulation Areas

While all waste accumulation areas will be informally inspected daily during waste generation activities, formal inspections of all container accumulation areas will be conducted and recorded at least weekly in accordance with the appropriate Radioactive Material License requirements. The PRSO or designee will conduct inspections that will be recorded in a dedicated field logbook, and a weekly inspection checklist will be completed. The container storage areas will be inspected and the containers checked to ensure the following:

- The containers will be checked for condition. If a container is not in good condition, the certified waste broker will be informed.
- The containers will be checked to ensure that they remain closed and secured at all times, except when adding or removing waste.
- The container label will be checked to ensure that it is visible and filled out properly.

7.2.6 Waste Transportation

In accordance with the MOU, the Navy’s radiological waste contractor will be responsible for transportation of the LLRW in accordance with the DOT Radioactive Material Transportation regulations of 49 CFR for offsite disposal. The contractor may supply DOT contamination surveys and radiation measurements on the outside of the container prior to shipment. The Navy's radiological waste contractor will ensure that empty containers being returned to vendors meet the release limits for equipment and materials.

LLRW transported from the site will be accompanied by a radioactive waste manifest or a Uniform Hazardous Waste Manifest, as appropriate. Preparation of the LLRW manifests are the responsibility of the Navy's radiological waste contractor.

BRAC will receive a copy of the manifest. The remaining copies will be given to the transporter. The manifest will be returned to the Navy signatory official in accordance with the Base's recordkeeping requirements.

7.2.7 Waste Disposal

The Navy's radiological waste contractor is responsible for the disposal of LLRW. The Navy's radiological waste contractor will coordinate closely with RASO and contractor to ensure proper transfer of custody of the waste and coordinate the shipment offsite. LLRW inventories will be managed under the appropriate Radioactive Material License.

7.3 Nonradiological Waste Management

7.3.1 Waste Classification

In general, wastes generated during the project will be assessed to determine proper handling and final disposition through chemical analysis, field testing, and possible generator knowledge. The exceptions are uncontaminated wastes (i.e., no contact with contaminated media or remediation chemicals) and trash.

Samples of these wastes will be collected and analyzed to determine whether the waste is a Hazardous Waste or a Nonhazardous Waste. Analysis will be based on the requirements of the offsite disposal facility and may include total petroleum hydrocarbons (typically C_4 to C_{40}), volatile organic compounds (VOCs), semivolatile organic compounds, corrosivity (pH), or California Assessment Manual 17 total metals. Based on the results, additional waste characterization may be needed or necessary to have the waste managed at an offsite waste management facility.

The project Environmental Manager should review the analytical data and characterize and classify the waste.

Samples will be collected in accordance with the general procedures in the following section and sent to a properly licensed laboratory for analyses. If the waste is placed in containers, one composite sample (and one grab for VOC analysis, if needed) will be collected for every 10 drums of each waste stream. If soil is staged in stockpiles or bins, a 4-to-1 composite will be collected and a grab sample for VOCs. If the waste (liquid) is placed in a tank or container, grab samples are appropriate. Offsite waste management facilities may require specific sampling per volume of waste accumulated under their waste acceptance policy.

7.3.2 Waste Sampling Procedures

7.3.2.1 Liquids

Analytical samples for liquid wastes will be collected from the 55-gallon drums before disposal; one composite sample will be collected for every 10 drums. Water samples will be collected by the following procedure:

1. Collect a water sample from a drum using a bailer or dipper if the water is homogenous or use a coliwasa if the water has more than one phase.

2. Fill the sample containers for volatile analyses first. Fill the 40-milliliter vials so there is no headspace in each vial.
3. Fill the sample containers for the remaining analyses.
4. Label and package the sample containers for shipment to the laboratory.

7.3.2.2 Solids

For soil, one grab sample and one composite sample will be collected for every 10 drums.

Soil samples procedures for collecting VOC samples are as follows:

1. Retrieve a core from the selected sample location.
2. Fill the appropriate sample jars completely full, with the sample from the core.

Soil sample procedures for collecting nonvolatile or metal samples are as follows:

1. Collect equal spoonfuls of soil from five randomly selected points and transfer into a stainless steel bowl.
2. Use a stainless-steel spoon and quartering techniques to homogenize the five samples.
3. Fill the appropriate sample jars completely full, with the homogenized sample.
4. Close the jars, label them, complete chain-of-custody documentation, and package them for shipment to the laboratory.

7.3.3 Waste Profile

Waste characterization information will be documented on a waste profile form provided by the offsite treatment or disposal facility and reviewed by a project Environmental Manager before being submitted to the Navy. The profile will be reviewed, approved, and signed by the appropriate Navy personnel. Signed profiles will then be submitted to the designated offsite facility.

The profile typically requires the following information:

- Generator information, including name, address, contact, and phone number
- Site name, including street/mailing address
- Process-generating waste
- Source of contamination
- Historical use for area
- Waste composition (e.g., 95 percent soil and 5 percent debris)
- Physical state of waste (e.g., solid, liquid)
- Applicable hazardous waste codes
- DOT proper shipping name.

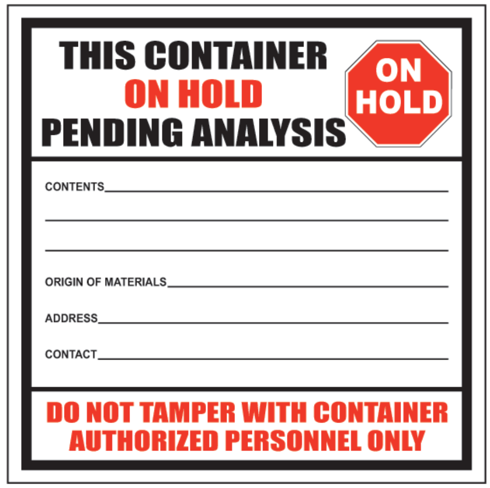
The contractor will coordinate with the disposal subcontractor to schedule the transportation of the waste to the offsite disposal facility after the copy of the approved waste profile is received.

7.3.4 Container Labeling

Waste containers containing contaminated media will be marked and labeled upon use concerning their contents. Each hazardous waste container will be marked in accordance with 22 California Code of Regulations 66262.32. In addition, containers will be labeled and in accordance with DOT 49 CFR 172.300 (Marking) and 172.400 (Labeling) and 40 CFR Subpart C. DOT labeling is only required before offering transportation offsite.

The marks will note the type of waste, location from which the waste was generated, and accumulation start date. One of the following labels will be used:

- **“Analysis Pending” or “Waste Material”**—Temporary label until analytical results are received, reviewed, and determined whether the waste is hazardous or not. This label will include the accumulation start date. An example of this mark is provided as follows:
  - Contents: Example – **soil from drill/auger cuttings**
  - Origin of Materials: **Former Hunters Point Naval Shipyard**
  - Address:
  - Contact Name and Phone Number:
  - Accumulation Start Date: **Please add under the Contact**



- **“Non-Hazardous Waste”**— If the waste is determined to be non-hazardous, apply the mark below with the following information:
  - Shipper: **Former Hunters Point Naval Shipyard**
  - Address:
  - Contents: **Example – soil from drill/auger cuttings**
  - Contact Name and Phone Number:
  - **Please add Accumulation Start Date somewhere on the mark**

- “**Hazardous Waste:** If the waste is determined to be hazardous, apply the mark below with the following information:
  - Name: **Former Hunters Point Naval Shipyard**
  - Address:
  - Phone:
  - City: **San Francisco**
  - State: **CA**
  - Zip:
  - USEPA ID No.:
  - Manifest number: **Add before transportation**
  - USEPA Waste No.: **EM to provide**
  - CA Waste No. **EM to provide**
  - Accumulation Start Date: **The date the waste was first placed in the container**
  - Physical State: **Check solid or liquid**
  - Hazardous Properties: **Check the appropriate hazard**
  - DOT proper shipping name: **EM to provide**

If additional assistance is needed in selecting the appropriate marks and labels, please contact the Environmental Manager or waste expert.

7.3.5 Waste Accumulation Areas

Although hazardous waste is not expected, if generated, the contractor will coordinate with the Navy to determine an appropriate site location to store the hazardous waste.

All containers will be physically handled in accordance with the APP/SSHP. Additional management requirements for the containers expected to be put into use can be found in **Table 7-2**.

Table 7-2. Non-LLRW Accumulation Requirements

Accumulating In:	Requirements
Drums/Small Containers	• Inspected upon arrival onsite for signs of contamination or deterioration. Any container arriving with contents or in poor condition will be rejected. • No penetrating dents are allowed that could affect the integrity of the drum. Pay special attention to dents at the drum seams. • Closed head drums: Will be inspected to verify that the bung will close properly. • Open head drums: Drum lids will be inspected to verify that the gasket is in good shape and that the lid will seat properly on the drum. • Arranged in rows of no more than 2 drums with at least 3 feet between rows. • Each container will be provided with its own mark and label, and the marks and labels must be visible. • Drums will remain completely closed with all lids, covers, bolts, and locking mechanisms engaged, as though ready for immediate transport, except when removing or adding waste to the drum. • Drums and small containers of hazardous waste will be transported using proper drum-handling methods, such as transportation by forklift on wood pallets, with drums secured together. Containers will be transported in a manner that will prevent spillage or particulate loss to the environment. • Drums will be disposed of with the contents. If the contents are removed from the drums for offsite transportation and treatment or disposal, the drums will be decontaminated prior to reuse or before leaving the site. • The outsides of the drums and containers must be free of hazardous waste residues. • Ignitable or reactive wastes will be stored at least 50 feet from the property line. • Drums and containers will not be located near a stormwater inlet or stormwater conveyance. • Drums containing waste liquids, hazardous or incompatible wastes will be provided with secondary containment capable of holding the contents of the largest tank and precipitation from a 24-hour, 25-year storm. • Liquid that accumulates in a secondary containment area will be removed and placed in containers within 24 hours. Removed liquids with a sheen will be characterized and classified. • New empty drums will be marked with the word “Empty”. Drums that are being reused will be marked with “Empty, last contained [previous contents]” • All containers will be tracked on the field transportation and disposal log

7.3.6 Inspection of Waste Accumulation Areas

Waste container accumulation areas will be inspected at least weekly for conditions that could result in a release of waste to the environment. Inspections will focus on conditions such as equipment malfunction, container or containment deterioration, signs of leakage or discharge. Specifically, containers (drums and roll offs) will be inspected for leaks, signs of corrosion, or signs of general deterioration.

Any deficiencies observed or noted during inspection will be corrected immediately. Appropriate measures may include transferring waste from a leaking container to a new container, replacing the liner or cover, or repairing the containment berm.

Inspections will be recorded in the project logbook or on an inspection form. Deficiencies and corrections will also be documented. All the following items will be noted in the logbook for each inspection:

- The location of the area
- Total number of containers present
- Date
- Verification that all containers are labeled with the accumulation start date, contents, Base point of contact, and any relevant hazards (such as flammable and oxidizer). Labels must be visible, legible, and not faded.
- The condition of containers. Good condition for containers is defined as no severe rusting, dents, structural defects, or leaks.
- The condition of secondary containment. Good condition for containment is defined as no structural defects or leaks.
- Verification that all containers are completely closed with all bolts, lids, and locking mechanisms engaged as though ready for immediate transport.
- Verification that containers are staged in rows not more than two drums wide, with labels facing outward and 3 feet of space between rows.
- Verification that all containers are being tracked on the transportation and disposal log.
- Verification that the accumulation area is clean and free of debris.

Verification that emergency response equipment is present if required for the waste being staged.

7.3.7 Waste Transportation

Each transportation vehicle and load of waste will be inspected before leaving the site, and the inspection will be documented in the logbook. The quantities of waste leaving the site should be recorded on a transportation and disposal log. A subcontractor licensed for commercial transportation will transport non-hazardous wastes. If the wastes are hazardous, the transporter will have a USEPA ID number and will comply with transportation requirements outlined in 49 CFR 171-179 (DOT) and 40 CFR 263.11 and 263.31 (Hazardous Waste Transportation).

The transporter will observe the following practices when hauling and transporting wastes offsite:

- Minimize impacts to general public traffic.
- Clean up waste spilled in transit.
- Line and cover trucks and trailers used for hauling contaminated waste to prevent releases and contamination.
- Decontaminate vehicles before reuse.

In accordance with the MOU, the Navy’s radiological waste contractor will be responsible for transportation of the LLRW in accordance with the DOT Radioactive Material Transportation regulations of 49 CFR for offsite disposal. The contractor may supply DOT contamination surveys and radiation measurements on the outside of the container prior to shipment. The Navy’s radiological waste contractor will ensure that empty containers being returned to vendors meet the release limits for equipment and materials.

Offsite transportation and disposal of hazardous or solid wastes will be handled by the selected waste contractor. All hazardous waste transported from the site will be accompanied by a Uniform Hazardous Waste Manifest and solid (nonhazardous) waste will be accompanied by a non-hazardous waste manifest or bill of lading, as appropriate. Navy personnel will be responsible for reviewing and signing all waste documentation, including waste profiles, manifests, and land disposal restriction notifications (manifest packages). Before signing the manifest, the designated Navy official will ensure that pre-transport requirements of packaging, labeling, marking, and placarding are met according to 40 CFR Parts 262.30–262.33, and 49 CFR Parts 100–178.

7.3.8 Waste Disposal

Hazardous and solid wastes will be transported offsite for appropriate treatment and disposal.

Hazardous waste will be disposed of or managed only at a hazardous waste disposal facility prequalified by the contractor and permitted for the disposal of the particular type of hazardous or solid waste generated.

7.4 Waste Minimization

To minimize the volume of hazardous and radioactive waste generated during the project, the following general guidelines will be followed:

- Waste material will not be contaminated unnecessarily.
- Work will be planned.
- Material may be stored in large containers, but the smallest reasonable container will be used to transport the material to its destination.
- Cleaning and extra sampling supplies will be maintained outside any potentially contaminated area to keep them free of contamination and to minimize additional waste generation.
- Mixing of detergents or decontamination solutions will be performed outside potentially contaminated areas.
- When decontaminating radioactively contaminated material, every effort should be made to minimize the generation of mixed waste.
- Contaminated material will not be placed with clean material.
- Wooden pallets inside the exclusion zone will be covered with plastic.
- Material and equipment will be decontaminated and reused when practicable.
- Volume reduction techniques will be used when practicable.

7.5 Compliance with CERCLA Offsite Rule

Consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Offsite Rule, wastes generated from remediation activities, such as contaminated soil or hazardous waste, at a CERCLA site may be transferred only to offsite facilities that have been deemed acceptable by the USEPA Regional Offsite Contact (40 CFR 300.440). With Naval approval, the contractor will request proof of Offsite Rule approval from the offsite disposal facility before transferring any wastes to an offsite facility.

Other disposal practices to be followed are as follows:

- Hazardous waste (State and Resource Conservation and Recovery Act [RCRA]) will be sent to an offsite, permitted, RCRA Subtitle C treatment, storage, and disposal facility or Wastewater Treatment Facility permitted under Clean Water Act.
- Nonhazardous wastes will be disposed of at an offsite RCRA Subtitle D facility permitted to receive such wastes. It is expected that the contaminated soil and debris will be classified as nonhazardous and disposed of at a Subtitle D facility.
- Decontamination water may be discharged to an onsite water treatment facility with written permission from the Base or disposed of offsite at a facility permitted to accept the waste.
- Uncontaminated debris may be sent to municipal landfills, landfills designated for construction/demolition debris or a recycling facility.
- General trash will be disposed of in dumpsters on-base.

The designated offsite facility will be responsible for providing a copy of the fully executed waste manifest and a certificate of treatment or disposal for each load of waste received to the generator.

7.6 Documentation

Documentation requirements apply to all waste managed during project activities. Field records will be kept of all waste-generating activities. All pages of the field data record log will be signed and dated by the person entering the data. In addition, the following information will be recorded in the log:

- Description of waste-generating activities
- Location of waste generation (including depth, if applicable)
- Type and volume of waste
- Date and time of generation
- Description of any waste sampling
- Name of person recording information
- Name of field manager at time of generation

7.7 Updating the Waste Management Plan

The Waste Management Plan section will be updated as changes in site activities or conditions occur, as changes in applicable regulations occur, and as replacement pages are added to this work plan. Revisions to waste management will be reviewed and approved by the Navy. All changes to the plan associated with radioactive or mixed waste will require approval from RASO.

SECTION 8

Environmental Protection Plan

This section briefly describes the environmental protection plan that will be implemented.

8.1 Land Resources and Vegetation

Parcel G is within a developed former industrial area with limited to no vegetation. The administrative provisions of the applicable permit programs will be applied to protect wetlands and streams, if appropriate.

8.2 Fish and Wildlife, Threatened, Endangered, and Sensitive Species

Several hundred types of plants and animals are believed to live at or near HPNS. No federally listed endangered or threatened species are known to permanently reside at HPNS or in the vicinity (Levine-Fricke and PRC, 1997); however, San Francisco Bay is a seasonal home to migrating fish and birds.

8.3 Wetlands and Streams

Two freshwater streams, Yosemite and Islais Creeks, flow into San Francisco Bay adjacent to the border with HPNS. Surface water resources at the site are limited to small groundwater seeps from exposed bedrock and the surface water in adjacent San Francisco Bay. The administrative provisions of the applicable permit programs will be applied to protect wetlands and streams, if appropriate.

8.4 Stormwater, Sediment, and Erosion Control

Stormwater, sediment, and erosion control will be managed through the Stormwater Pollution Prevention Plan (SWPPP), to be prepared under separate cover, and the use of BMPs.

8.4.1 Stormwater Pollution Prevention

Stormwater pollution prevention, otherwise known as stormwater management, includes measures that can reduce potential stormwater pollution from industrial activity pollutant sources. Stormwater management includes the following BMPs: a pollution prevention team, risk identification and assessment, preventive maintenance, good housekeeping, site security, spill prevention and response, stormwater pollution prevention, sediment and erosion prevention, inspection and monitoring, and personnel training. These BMPs help to identify and eliminate conditions and practices that could cause stormwater pollution. The SWPPP details the entire program to include the regulatory requirements and methods used to meet these requirements.

Inspections play a large role in the prevention of releases and pollution of stormwater. Qualified contractors and personnel perform inspections as described in the SWPPP. These inspections are documented and retained pursuant to the requirements of **Section 6**.

8.4.2 Stockpile Control

Stockpiles, although not expected, will be managed to ensure that any possible cross contamination with surrounding surfaces will be minimized to the extent possible. These measures will include, at a minimum, the following:

- All excavated material will be placed on plastic to prevent contact with the surface.
- All stockpiles will be covered with plastic or tarps at the end of shift or when stockpile additions or removals are complete and monitored on a weekly basis.
- BMPs (such as bio waddles, straw waddles, and erosion berms) will be used around stockpiles to prevent material migration.
- Stockpiling of known hazardous material will not be allowed. Hazardous material will be packaged as hazardous waste and stored under RCRA controls pending removal by a waste broker.

8.4.3 Nonradiological Hazardous Materials

Hazardous material will be managed in accordance with permits, plans, rules and laws. At a minimum, the following will be required:

- Hazardous material will be properly labeled and stored.
- Hazardous waste will be placed into approved containers and stored in designated Satellite Accumulation Areas or Waste Accumulation Areas.
- Hazardous material or waste containers will be kept closed when not in use.
- Before workers opening any container or package with hazardous material, the project Environmental Manager should be consulted to determine whether pre-entry monitoring is required.

8.5 Air Quality and Dust Control

All intrusive activities will comply with the substantive requirements of the Bay Area Air Quality Management District Rule 40 and Regulations 6-305 and 8 pertaining to fugitive dust emissions and maintaining covering and stockpiling materials. Fugitive emissions will be minimized to the extent possible. Subsurface soil within the HPNS is expected to be moist and not require dust suppression. These measures will include, at a minimum, the following:

- Visible dust caused by intrusive methods will require work to be paused and the source of the dust corrected by dust suppression.
- Continuous radiological air samples (general area) will be collected during any intrusive work within areas of known or potential radiological contamination or material.
- Areas with known or suspected radiological material that could become airborne from light winds (fine or powdered material) will be evaluated for a suitable stabilization method (dust control agent, fixatives, surfactants, or covering with erosion control covers).
- Area monitoring with direct reading dust monitors and photoionization detector.
- Stationary high-volume area sampling.

Additionally, a site-specific dust management plan will be developed. Any air permits (e.g., local air quality board) that are required for the performance of work under this contract will be detailed in the project environmental plan.

8.5.1 Radiological Air Sampling

Airborne activity monitoring (continuous or grab samples) and engineering controls may be required during work when deemed appropriate by the License, PRSO, contractor, or the Navy. To control occupational exposures, establish PPE, and determine respiratory protection requirements, monitoring and trending for airborne radioactive material will be performed as necessary. Engineered controls will be implemented if required to maintain airborne concentrations below the applicable derived air concentration (DAC) value for the ROCs (**Table 8-1**).

During work, if the airborne concentration exceeds the appropriate DAC, ongoing activities will cease and the affected location will be posted until the source of the airborne concentration is eliminated and levels are confirmed to be below the appropriate DAC. Air monitoring will be performed using the methods described in SOP RP-107, *Measurement of Airborne Radioactivity* (**Appendix D**). It is not anticipated that airborne contamination would occur.

Table 8-1. Derived Air Concentrations

Radionuclide	Radiation	DAC (µCi/mL)
^{226}Ra	Alpha (α)	3.0×10^{-10}
^{239}Pu		3.0×10^{-12}
$^{232}Th^{a}$		5.0×10^{-13}
^{235}U		6.0×10^{-10}
$^{90}Sr^{b}$	Beta (β^-)	8.0×10^{-9}
^{137}Cs	Beta/gamma (β^-, γ)	6.0×10^{-8}

Notes:

[a]The most restrictive DAC for alpha-emitting nuclides is ^{232}Th. The most restrictive DAC for the ROCs in an area will be used.

[b]The most restrictive DAC for beta-emitting nuclides is ^{90}Sr. The most restrictive DAC for the ROCs in an area will be used.

µCi/mL = microcurie(s) per milliliter

8.5.2 Nonradiological Area and Personal Air Monitoring

Air monitoring for nonradiological contaminants is expected during fieldwork at HPNS. In keeping with the philosophy of “Zero Dust,” engineering controls will be the primary method to eliminate dust. To verify the effectiveness of the controls, the use of area direct reading dust monitors (e.g., DataRAM) may be used. Area dust monitors may be deployed at select locations around the boundary of the site (environmental locations).

In addition, stationary high-volume sampling will include upwind and downwind monitoring for the ROCs, total suspended particulates, arsenic, lead, manganese, particulate matter with particles larger than 10 microns in size, and asbestos.

Monitoring data will be compared with the threshold concentration levels developed for the project site. If an analyte concentration exceeds its threshold level, the upwind and downwind results will be compared to identify whether the exceedance was caused by onsite activities. If onsite activities are found to be the cause of an exceedance, the SSHO will immediately implement corrective actions to enhance the dust control measures being implemented. These measures include, but are not limited to, applying additional water and soil stabilizers, reducing driving speeds on unpaved roads, and modifying the equipment and approach used to perform the work activities.

Breathing zone action levels will be established for non-radiological contaminants (e.g., heavy metals and polychlorinated biphenyls), based on prior soil sampling at the site and task (e.g., drilling and excavation). Direct reading monitoring equipment (such as DataRAM and photoionization detector) will be used to verify action levels are not exceeded during work tasks.

Each project task plan will evaluate if nonradiological personal integrated air sampling is required, in addition to direct reading monitoring. The SSHP will be updated via a Field Change Request if additional monitoring is needed based on task-specific chemicals of concern. The APP and SSHP further discuss personal air monitoring requirements of the project.

8.6 Noise Prevention

Using standard OSHA occupational noise evaluation methods, the time weighted average for any 8-hour period will not exceed 90 decibels (dBA) to any worker. In addition, the contractor will endeavor to limit noise directly resulting from project work at or below 80 dBA at the task area boundary, or 70 dBA at the HPNS boundary.

8.7 Construction Area Delineation

Construction area delineation will be evaluated upon arrival of the advance project personnel. Following this evaluation, minor modifications will be made to the project plans and procedures to reflect the current conditions.

8.8 Traffic Control Plan

Not applicable.

8.9 General Operations

General operations will be governed under this work plan to ensure that any operation conforms to the requirements listed within. These requirements are specific to the type of hazard (e.g., radiological, hazardous material, and health and safety) and further require that each task have a corresponding AHA. All work will be released by the cognizant contractor before work is performed. Review of the general operations AHA will include all environmental programs and permits to ensure compliance.

8.10 Spill Prevention, Response, and Reporting

The project spill plan is provided in the APP/SSHP.

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Appendix A
Comments and Responses to Comments

Appendix B
Sampling and Analysis Plan

Appendix C
Soil Reference Background Area Work Plan

Appendix D
Contractor-specific Radioactive Material License, Standard Operating Procedures, Organizational Chart, and Radiation Protection Plan

Appendix E
Memorandum of Understanding

Naval Facilities Engineering Command Southwest
BRAC PMO West
San Diego, CA

Final

Soil Reference Background Area Work Plan

Former Hunters Point Naval Shipyard
San Francisco, California

January 2019

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Acronyms and Abbreviations

^{40}K	potassium-40
^{90}Sr	strontium-90
^{137}Cs	cesium-137
^{214}Pb	lead-214
^{226}Ra	radium-226
^{230}Th	thorium-230
^{232}Th	thorium-232
^{234}U	uranium-234
^{235}U	uranium-235
^{238}U	uranium-238
^{239}Pu	plutonium-239
µR/hr	microroentgen(s) per hour
APP	accident prevention plan
ASTM	ASTM International (formerly American Society for Testing and Materials)
bgs	below ground surface
CH2M	HILL, Inc.
cpm	counts per minute
cpm/µR/hr	counts per minute per microroentgen per hour
DQO	data quality objective
ft^2	square feet
GIS	geographic information system
GPS	global positioning system
HPNS	Hunters Point Naval Shipyard
IDW	investigation-derived waste
KW	Kruskal-Wallis
m/s	meter(s) per second
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCA	multi-channel analyzer
MDCR	minimum detectable count rate
NaI	sodium iodide
NaI(Tl)	thallium-doped sodium iodide
Navy	Department of the Navy
NORM	naturally occurring radioactive material

NRC	Nuclear Regulatory Commission
NUREG	Nuclear Regulatory Commission Regulation
pCi/g	picocurie per gram
PPE	personal protective equipment
PRSO	Project Radiation Safety Officer
RASO	Radiological Affairs Support Office
RBA	reference background area
RG	remediation goal
ROC	radionuclide of concern
ROICC	Resident Officer in Charge of Construction
RPM	Remedial Project Manager
SAP	sampling and analysis plan
SOP	standard operating procedure
SSHP	site safety and health plan
TCRA	Time-critical Removal Action
USGS	U.S. Geological Survey

SECTION 1

Introduction

This work plan provides the details for the radiological characterization of soil reference background areas (RBAs) at the former Hunters Point Naval Shipyard (HPNS) in San Francisco, California. Four onsite RBAs and one offsite RBA, located at the City of San Francisco's John McLaren (McLaren) Park, have been identified for radiological characterization. The radiological characterization will be conducted in accordance with the general approach and methodologies that are provided in the Parcel G Removal Site Evaluation Work Plan (Parcel G Work Plan) (Navy, 2018), Sampling and Analysis Plan (SAP) (included in the Parcel G Work Plan), and a separate Accident Prevention Plan/Site Safety and Health Plan (APP/SSHP). Specific procedures to ensure data quality and worker safety will be described in the SAP and APP/SSHP.

Radiological surveys and remediation have been conducted at HPNS as part of a basewide Time-critical Removal Action (TCRA). Additional efforts to investigate and, if necessary, remediate radiologically impacted sites in Parcels B, C, D-2, E, G, UC-1, UC-2, and UC-3 are planned. The RBA data will be used to evaluate site investigation data to support a final decision on whether residual radioactivity is found to exceed the remediation goals (RGs). The RBA data will also be compared to site investigation data to determine whether further remediation is necessary.

SECTION 2

Purpose and Data Quality Objectives

The reference background area data will be collected during the implementation of this work plan to support a final decision on whether residual radioactivity is found to exceed the RGs at HPNS. The RGs presented in **Section 3** specify that the radium-226 (^{226}Ra) RG be set at 1 picocurie per gram (pCi/g) above the background concentration. Previous site radiological surveys and remediation activities did not estimate a reference background concentration for other radionuclides, such as cesium-137 (^{137}Cs) and strontium-90 (^{90}Sr). Both ^{137}Cs and ^{90}Sr are common nuclear fission products that are present worldwide because of radioactive fallout from weapons testing. This work plan describes methods for obtaining RBA data sets for the radionuclides of concern (ROCs) by establishing the following:

- Descriptive statistics and distributions of background concentrations, in pCi/g, for the ROCs, including ^{137}Cs, ^{226}Ra, and ^{90}Sr
- Descriptive statistics and distributions of background concentrations for the naturally occurring radioactive material (NORM) radionuclides, including those associated with the uranium decay series, thorium decay series, and potassium-40 (^{40}K)

Additionally, the data collection protocols and RBA data sets may be used for site evaluation scenarios listed in the Parcel G Work Plan and other work plans (e.g., NORM evaluations, comparison to background, alternative statistical evaluations, and dose and risk analyses).

The data quality objectives for the RBA investigation are as follows:

- **Step 1-State the Problem**: HPNS was expanded over time using fill materials with a range of concentrations of NORM. Construction and remediation projects over the past 60 years have disturbed the surface soil, making a determination of background concentrations for anthropogenic radionuclides from fallout difficult. Previous HPNS soil background values did not provide ^{226}Ra concentrations representative of all fill materials found at HPNS and did not include other NORM or fallout radionuclides.
- **Step 2-Identify the Objective**: Establish representative background soil data sets for comparison and evaluation of soil data collected from HPNS.
- **Step 3-Identify Inputs to the Objective**: Soil analytical data for ROCs using analytical methods are summarized in **Section 3** and detailed in the SAP, included in the Parcel G Work Plan. Gamma scanning measurements will be performed within the RBAs to confirm the areas are free of elevated gamma levels and are suitable for sampling (**see Section 4.1**).
- **Step 4-Define the Study Boundaries**: RBAs at HPNS in Parcels B, C, D-1, and D-2 (**Figure 3-1**), and in an undisturbed off-base location (**Figure 3-2**) will provide a range of background estimates. In Parcels B, C, D-1, and D-2, surface soil samples will be collected from 0 to 6 inches below ground surface (bgs), and subsurface soil samples will be collected from 1- to 2-foot bgs intervals to a depth of up to 10 feet bgs. At the off-base location, surface soil samples will be collected from 0 to 6 inches bgs, and subsurface soil samples will be collected from the 1- to 2-foot bgs interval.
- **Step 5-Develop Decision Rules**: RBA data sets will be compared and evaluated to provide representative RBA data sets with a description to assist in determining applicability for specific projects at HPNS. The data evaluation process is summarized in the following list and detailed in **Section 4**:

- Identify outliers graphically or statistically using Dixon and Rosner's tests for outliers by comparing the calculated Q values or R values to the critical value, corresponding to a confidence level of 95 percent.
    - If outliers are identified graphically or statistically (Q value or R value is greater than critical value), the outlier will be investigated to attempt to determine whether the outlier is the result of contamination, data quality issues, an environmental issue (e.g., different soil type), or an unidentified issue.
    - If no outliers are identified, the entire data set will be used in its entirety.
- Determine statistical difference between data sets using the non-parametric Kruskal-Wallis (KW) test by comparing the calculated p-value against 0.05 significance level.
    - If the results of the KW test indicate that two or more data sets are statistically similar (p-value is greater than significance level), those data sets may be combined to form a larger data set representing more of HPNS, such as a larger area, multiple soil depths, or additional soil types.
    - If the results of the KW test indicate that a data set is statistically different from other data sets (p-value is less than significance level), that data set will not be combined with other data sets and will be representative of a specific area, soil depth, or soil type.
- Evaluate secular equilibrium conditions.

* **Step 6-Specify the Performance Criteria**: A statistical data evaluation will be conducted to identify appropriate soil background data sets and calculate descriptive statistics to facilitate future comparisons with site-specific data. The purposes of the data evaluation are as follows:
    - Identify outliers using Dixon and Rosner's tests for outliers.
    - Determine statistical differences between soil types using the KW test.
    - Compare soil data sets from surface gamma scan surveys, and surface and subsurface analytical concentrations against different identified soil types and against each RBA per sample depth.
    - Establish one or more representative RBA data sets.
* **Step 7-Develop the Plan for Obtaining Data**: RBAs will be characterized by conducting gamma scan surveys of the accessible surface areas and collecting systematic surface and subsurface soil samples, as follows:
    - In Parcels B, C, D-1, and D-2, surface soil samples will be collected from 0 to 6 inches bgs, and subsurface soil samples will be collected from 1- to 2-foot bgs intervals to a depth of up to 10 feet bgs.
    - At McLaren Park, an offsite location with undisturbed surface soil, surface soil samples will be collected from 0 to 6 inches bgs and subsurface soil samples will be collected from the 1- to 2-foot bgs interval.
    - During soil sampling activities, a professional geologist registered in California will annotate the lithologic characteristics and provide accurate and consistent descriptions of soil characteristics.
    - Soil samples will be analyzed for the applicable ROCs along with NORM radionuclides and fallout radionuclides by accredited offsite laboratories, and the results will be evaluated as described in Steps 5 and 6.

Survey Design and Implementation

3.1 Survey Design

The concentrations of NORM radionuclides and fallout radionuclides in soil at HPNS are variable because of the natural variability of native soil and the variability in erosion and deposition of surface soil and fallout radionuclides. In addition, portions of the site were created with fill materials originating from multiple offsite sources. Much of the fill was obtained by grading the hilltop immediately north of HPNS. The source of fill derived from the hilltop is the Hunters Point Shear Zone, a complex structural mixture of serpentinite, shale, sandstone, chert, and gabbro. Fill soil was also obtained from sediment dredged from San Francisco Bay and imported from local quarries and construction sites. Fill soil was generally placed in layers; however, the layering is not contiguous across the shipyard. Soil lithology in filled areas is not readily known at any given location.

Concentrations of fallout radionuclides are variable in soil at HPNS because of deposition, erosion, and mixing during placement of fill soil. Thus, the concentrations of naturally occurring and fallout radionuclides in soil vary by location and depth. The RBA is designed to capture data that are comparable to survey data collected during site investigations at HPNS and representative of the wide range of background concentrations present at HPNS.

Because of potential spatial variability across HPNS, four distinct onsite RBAs have been identified for characterization. In addition, one undisturbed offsite location was selected for characterization of fallout radionuclides. RBAs are geographical areas from which representative radioactivity measurements are collected for comparison with measurements collected in an impacted area (i.e., a survey unit). RBAs are areas that have been identified as non-impacted and should have physical, geological, chemical, radiological, and biological characteristics similar to those of the impacted area being investigated. The RBA characterization methodology will consist of a combination of radiological gamma surveys and soil sampling to establish the HPNS background conditions. Samples will be collected from independent surface and subsurface soil depth intervals. The analytical soil data from the RBAs will be used to generate background population statistics and establish parameters (e.g., mean, median, standard deviation, range).

3.1.1 Radionuclides of Concern

The ROCs vary across media and parcels at HPNS. Because the intent of this RBA characterization is to address all soil ROCs at HPNS, the various soil ROCs and their respective RGs in Parcels B, C, D-2, E, G, UC-1, UC 2, and UC-3 are presented in **Table 3-1**. RBA samples and measurements will be collected and evaluated to establish representative data sets defining natural background and fallout levels of anthropogenic radionuclides. The analytical methods and the radionuclides being analyzed for will be presented in the SAP and are summarized in **Section 3.1.7**.

Table 3-1. Radionuclides and Remediation Goals for Various Soil Areas at HPNS

Radionuclide	Residential Soil Remediation Goal[a] (pCi/g)
^{137}Cs	0.113
^{239}Pu	2.59
^{226}Ra	1.0
^{90}Sr	0.331
^{232}Th	1.69
$^{235+D}U$	0.195

[a]All RGs will be applied as concentrations above background.

^{232}Th = thorium-232

$^{235+D}U$ = uranium-235+D

^{239}Pu = plutonium-239

3.1.2 Survey Methodology Summary

The RBA characterization will incorporate three survey techniques: gamma spectroscopy scans, surface soil sampling, and subsurface soil sampling. The gamma spectroscopy scan will be performed by surveying the accessible surface areas, following removal of any durable cover (if applicable). Soil sampling will occur at various depths from 0 to 10 feet bgs. The sampling design is representative of the survey unit sampling designs in terms of sample depths, spatial distribution, and number of samples to be collected.

3.1.3 Reference Background Area Locations

As part of the previous HPNS TCRA activities, five areas were used as RBAs for soil and were characterized at different times beginning in 2006. Because of access restrictions, this work plan has been designed to use four of the previously established RBA soil areas with adjustments to the shape and size of the areas. In this work plan, the four historically non-impacted RBAs are identified as the following (shown on **Figure 3-1**):

- RBA-1, located on Parcel B
- RBA-2, located on Parcel C
- RBA-3, located on Parcel D-1
- RBA-4, located on Parcel D-2

These four historical RBAs are still considered non-impacted, representative of much of the soil at HPNS, and suitable for use as RBAs. Justification for selecting the non-impacted RBAs is as follows:

- RBA-1, located in the area behind Building 116 on Parcel B, is considered to contain material like that encountered in nearby soils and has been covered with asphalt since the early 2000s.
- RBA-2, southeast of Lockwood Avenue adjacent to Parcel C, is believed to be unimpacted, has no history of radiological use, and has been covered with asphalt since approximately 2015.
- RBA-3, the area between Building 526 and Berth 29 in Parcel D-1, is considered to contain material like that encountered in nearby soils in the Parcel E survey units and has no history of radiological use. The area has been paved with asphalt since the previous RBA characterization.

- RBA-4, located in the Building 813 parking lot in Parcel D-2, has no history of radiological use, is considered to contain material like that encountered in the Parcel G survey units, and has been paved with asphalt since the previous RBA characterization. The land area in Parcel G was originally part of Parcel D and is adjacent to RBA-4; therefore, RBA-4 is considered representative of Parcel G site conditions.

Following characterization of each RBA, a detailed data evaluation will be performed to confirm its suitability as an appropriate RBA. In addition to the four onsite RBAs, an offsite RBA has been identified for surface soil characterization. The City of San Francisco's McLaren Park is located roughly 2.5 miles west of HPNS. McLaren Park is non-impacted by the Department of the Navy (Navy) radiological activities and contains areas where surface soil has been undisturbed by construction activities since prior to atmospheric nuclear weapons testing. McLaren Park occupies 312 acres and includes a nine-hole golf course, playgrounds, amphitheater, and 350,000-gallon water tank. The land area between John F Shelley Drive and Mansell Street contains undisturbed terrain and has been selected as a potential location for the offsite RBA (RBA-McLaren). The RBA-McLaren is shown on **Figure 3-2**. The exact sample locations within McLaren Park may be adjusted based on consultation with the City of San Francisco. Other locations in the San Francisco Bay Area that have been similarly undisturbed may also be used as potential offsite RBA locations.

Both surface gamma scan surveys and surface soil samples will be collected from RBA-McLaren to provide a surface soil data set representative of undisturbed surface soil areas. Additional sample locations at McLaren Park or additional RBA locations may be added as necessary to characterize different soil types and depositional areas.

3.1.4 Number of Samples

The minimum number of samples to be collected was determined using the Parcel G Work Plan and Nuclear Regulatory Commission (NRC) criteria. The NRC criteria for providing characterization of a complex site, found in United States Nuclear Regulatory Commission Regulation (NUREG)-1505 (Section 13.5, page 13-11, last paragraph, second sentence), states that "four reference areas each with between 10 and 20 samples in each should generally be adequate" (NRC, 1998a). Table 13.5, *Power of the F-test when* $\omega^2=\sigma^2$, in NUREG-1505, shows that 20 samples collected from each of 6 reference area data sets will provide 95 percent confidence that the reference area data sets can be combined if they are similar. In this example, the power of this test is 99 percent, meaning there is a 1 percent probability that the data sets will be incorrectly combined when they are not similar. The proposed RBA survey design includes collecting 25 samples from each of up to 10 reference area data sets, providing a power greater than 99 percent while maintaining 95 percent confidence that the data sets can be combined if they are similar.

The null hypothesis (H_o) is that the mean concentrations for each RBA data set are similar and can be combined. The alternative hypothesis is that the mean concentrations for at least one of the RBA data sets are not similar.

Type I decision error would occur when the data sets are not combined when the means are actually equal. The consequence of a Type I error includes having a smaller number of samples in the RBA data set, resulting in less statistical power for evaluating survey unit data sets, potentially resulting in removing soil that has ROC concentrations below the RGs.

Type II decision error would occur when the data sets are combined when the means are actually different. The consequence of a Type II error would include artificially increasing the variability in the combined RBA data set, thereby decreasing the required number of samples in each survey unit.

The Parcel G Work Plan provides a number for samples calculation and determines that a minimum of 18 samples will be collected in each survey unit and each RBA data set; however, that number will be recalculated following the RBA characterization described in the work plan. In order to satisfy both the NRC criteria and the Parcel G Work Plan, the number of samples in each data set was increased to 25 to ensure that sufficient analytical data will be available. Therefore, 25 surface soil samples and 25 subsurface soil samples will be collected from RBAs 1 through 4 for a total of 100 onsite surface soil samples and 100 onsite subsurface soil samples. Additionally, 25 surface soil samples and 25 subsurface soil samples will be collected from RBA-McLaren. Overall, a minimum of 250 soil samples will be collected, as follows:

- 25 surface and 25 subsurface soil samples from RBA-1, located on Parcel B
- 25 surface and 25 subsurface soil samples from RBA-2, located on Parcel C
- 25 surface and 25 subsurface soil samples from RBA-3, located on Parcel D-1
- 25 surface and 25 subsurface soil samples from RBA-4, located on Parcel D-2
- 25 surface and 25 subsurface soil samples from RBA-McLaren, located offsite

This sampling effort will result in up to 10 RBA data sets of 25 samples each from 5 different RBA locations. Additional data sets may be defined based on soil type or other visual observations of the soil samples.

3.1.5 Sample Locations

To simplify the sampling design, the area of each onsite RBA was modified to establish approximately 2,500-square-foot (ft^2) areas within each of the four historical RBA footprints.

3.1.5.1 RBA-1 through RBA-4

For the surface soil sample locations within RBA-1 through RBA-4, a triangular grid will be used to place 25 systematic sample locations. As illustrated on **Figure 3-3**, surface soil samples will be collected from the top 6 inches of soil material at each location for the surface soil data set. For the purposes of this investigation, onsite surface soil is defined as the uppermost 6-inch interval of soil beneath the asphalt and road base materials installed as part of the durable cover.

Within each 2,500-ft^2 surface area, 5 subsurface sampling locations have been established using 5 of the 25 systematic surface sample locations: 1 at the approximate center of each area, and the other 4 located near each of the 4 corners of the area. Subsurface soil samples will be collected from the five sampling locations. As illustrated on **Figure 3-3**, subsurface soil samples will be collected by drilling to a depth of approximately 10 feet bgs from which five subsurface soil samples will be extracted. The proposed subsurface sample depth intervals are the 1- to 2-foot bgs interval, the 3- to 4-foot bgs interval, the 5- to 6-foot bgs interval, the 7- to 8-foot bgs interval, and the 9- to 10-foot bgs interval. If the geologist determines that lithologic characteristics support modification of the proposed depth increments, additional samples may be collected, or the proposed sample depth may be adjusted to match the lithologic characteristics of the soil column. This is further described in **Section 3.2.5**.

Figures 3-4 through **3-7** show the planned surface and subsurface sample locations from RBAs 1 through 4.

3.1.5.2 RBA-McLaren

The planned area for RBA-McLaren, located offsite and within McLaren Park, is a square area measuring approximately 75 feet by 75 feet. Within the estimated 5,600-ft^2 (520-square-meter) surface area, 25 surface sampling locations have been established using a random start systematic triangular grid pattern. Surface soil samples will be collected as described in **Section 3.2** from the top 6 inches of soil at each location for the surface soil data set. Subsurface soil samples will be collected as described in **Section 3.2**, from the approximately 1- to 2-foot bgs interval at each location for the subsurface soil data set. **Figure 3-8** shows the planned sample locations for RBA-McLaren. Additional samples may be collected from other locations if areas of relatively undisturbed surface soil with varying geological properties are identified during field sampling activities.

3.1.6 Field Instrumentation, Gamma Detectors

Gamma scanning instruments have been selected to provide a high degree of defensibility, based on their capability to measure and quantify gamma radiation and position. Because there are several specific gamma detection platforms that may be used during upcoming work at HPNS, the minimum requirements for a suitable gamma scan survey system are as follows:

- Thallium-doped sodium iodide (NaI[Tl]) or plastic gamma scintillator
- Equipped with spectroscopy
- Automatic data logging
- Real-time positioning (global positioning system [GPS] or equivalent)

During this initial RBA characterization, gamma scan surveys will be performed using one or more of the instruments shown in **Table 3-2** (or other instruments with equivalent detection sensitivity and meeting the minimum requirements listed above).

Table 3-2. Gamma Survey Instruments

Meter Manufacturer and Model	Detector Manufacturer and Model	Detector Type	Use
Ludlum 2221, Osprey MCA	Bicron 3x5x16 / 3SSL-X	3-inch x 5-inch x 16-inch NaI(Tl) detector	Soil gamma scan surveys
Ludlum 2221, MCA	Ludlum Model 44-20	3-inch x 3-inch NaI(Tl) detector	Soil gamma scan surveys, sample screening, soil core surveys

Note: Equivalent alternative instrumentation may be used following approval by the Project Radiation Safety Officer (PRSO) and Field Team Lead.

MCA = multi-channel analyzer

The field survey instrumentation will be calibrated, used, and maintained in accordance with the requirements and standard operating procedures (SOPs) provided in the Parcel G Work Plan and according to the SAP.

3.1.6.1 Instrument Detection Calculations

The equations to calculate efficiencies, minimum detectable concentrations (MDCs), and minimum detectable count rates (MDCRs) at HPNS are based on the methodology and approach used in *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)* Chapter 6 (USEPA et al., 2000) and NUREG-1507 Chapter 6 (NRC, 1998b).

3.1.6.2 Gamma Surface Activity

Estimating the amount of radioactivity that can be confidently detected using field instruments is performed by adapting the methodology and approach used in MARSSIM Section 6.7.2.1 (USEPA et al., 2000) and NUREG-1507 Section 6.8.2 (NRC, 1998b) for determining the gamma scan MDC for photon-emitting radionuclides.

The scan MDC (in pCi/g) for areas is based on the area of elevated activity, depth of contamination, and the radionuclide (energy and yield of gamma emissions). The computer code Microshield can be used to model expected exposure rates from the radioactive source at the detector probe sodium iodide (NaI) crystal and includes source-to-detector geometry. The geometry is used to calculate the total flow of photons incident upon the detector crystal, called the gamma fluence rate, ultimately corresponding to an exposure rate that is associated with a count rate in the instrument.

The amount of radiation the detector crystal is exposed to from the modeled source is used to determine the relationship between the detector's net count rate and the net exposure rate (counts per minute per microroentgen per hour [cpm/µR/hr]).

3.1.6.3 Gamma Scan Minimum Detectable Concentration

The minimum detectable number of net source counts in the scan interval is given by s_i, which can be arrived at by multiplying the square root of the number of background counts (in the scan interval) by the detectability value associated with the desired performance (as reflected in *d'*), as shown in **Equation 3-1** (Equation 6-8 of MARSSIM):

Equation 3-1

$$s_i = d'\sqrt{b_i}$$

Where:

> *d'* = index of sensitivity (α and β errors [performance criteria])
> b_i = number of background counts in scan time interval (count)
> *i* = scan or observation interval (seconds)

For scanning at HPNS, the required rate of true positives will be 95 percent, and the false positives will be 5 percent. From Table 6.5 of MARSSIM, the value of *d'*, representing this performance goal, is 3.28. The MDCR, in counts per minute (cpm), is calculated by **Equation 3-2** (Equation 6-9 of MARSSIM):

Equation 3-2

$$MDCR = s_i \times (60/i)$$

Where:

> s_i = minimum detectable number of net source counts in the scan interval
> *i* = scan or observation interval (seconds)

Next, the MDCR is used to calculate the *Surveyor* MDCR by applying a surveyor efficiency factor as follows in **Equation 3-3** (Page 6-45 of MARSSIM):

Equation 3-3

$$MDCR_{Surveyor} = \frac{MDCR}{\sqrt{p}}$$

Where:

> *MDCR* = minimum detectable count rate
> *p* = surveyor efficiency

After a surveyor efficiency is selected, the relationship between the $MDCR_{surveyor}$ and the radionuclide concentration in soil (pCi/g) is determined. This correlation requires two steps: 1) establish the relationship between the detector's net count rate and net exposure rate (cpm/µR/hr), and 2) determine the relationship between the radionuclide contamination and exposure rate. The relationship between the detector's net count rate and net exposure rate may be determined analytically using reference guidance documents, or obtained from the detector manufacturer. Modeling (using Microshield) of the source area is used to determine the net exposure rate produced by a given concentration of a radionuclide at a specific distance above the source. The scan MDC is calculated by **Equation 3-5** (Page 6-45 of MARSSIM):

Equation 3-5

$$ScanMDC = \left(\frac{MDCR_{surveyor}}{\epsilon_{inst}}\right) \times \left(\frac{Radionuclide\ Concentration[pCi/g]}{Exposure\ rate[\mu R/h]}\right)$$

Where:

$MDCR_{surveyor}$ = minimum detectable count rate surveyor
ε_{imst} = instrument efficiency (cpm/μR/hr)
Radionuclide Concentration = modeled source term concentration (pCi/g)
Exposure Rate = result of model (microroentgen(s) per hour [μR/hr])

3.1.6.4 Example Gamma Scan Minimum Detectable Concentrations

An example a priori scan MDC calculation is provided herein for ^{226}Ra using a Ludlum 2221 with a Model 44-20 (3-inch by 3-inch NaI) detector. This example assumes a background level of 18,000 cpm, and 95 percent correct detections and 95 percent false positive rates resulting in a *d′* of 3.28. A scan rate of 0.5 meter per second (m/s) (19.7 inches per second) provides an observation interval of 2 seconds (based on a diameter of approximately 1 meter for the modeled area of elevated activity). The $MDCR_{surveyor}$ was then calculated assuming a surveyor efficiency (ρ) of 1 (assumes automated data logging). The scan MDC is calculated as follows:

$$s_i = 3.28 * \sqrt{\frac{18{,}000 * 2sec}{60sec}} = 80\ counts$$

$$MDCR = 80 * \left(\frac{60\ sec}{2\ sec}\right) = 2{,}410\ cpm$$

$$MDCR_{surveyor} = \frac{2{,}410\ cpm}{\sqrt{1}} = 2{,}410\ cpm$$

The relationship between the detector's net count rate and net exposure rate has been obtained from the detector manufacturer and is 2,300 cpm/μR/hr. The relationship between the radionuclide contamination and exposure rate has been determined by modeling (using Microshield) the source area to determine the net exposure rate produced by a given concentration of a radionuclide at a specific distance above the source. The Microshield Version 11.20 model has a source activity of 1 pCi/g of ^{226}Ra, a circular area of elevated activity of 1 square meter, a contaminated zone depth of 15 centimeters (6 inches), and a soil density of 1.6 grams per cubic centimeter. The modeling code determined an exposure rate at the detector height (dose point) of 10 centimeters (4 inches) above the source to be 1.130 μR/hr. The scan MDC for this source geometry is calculated as follows:

$$ScanMDC = \left(\frac{2{,}410cpm}{2{,}300cpm/\mu R/h}\right) \times \left(\frac{1.0[pCi/g]}{1.130[\mu R/h]}\right) = 0.93\ pCi/g$$

Additional a priori determinations are provided in **Table 3-3**. The Microshield model parameters are identical to those described in the previous example, using either ^{226}Ra with a concentration of 1 pCi/g, or ^{137}Cs with a concentration of 0.113 pCi/g.

Table 3-3. A Priori Scan MDCs

NaI Detector	Remediation Goal	Scan MDC
Ludlum 44-20, 3x3	^{226}Ra, 1.0 pCi/g	0.93 pCi/g
	^{137}Cs, 0.113 pCi/g	2.30 pCi/g
Bicron 3SSL-X, 3x5x16	^{226}Ra, 1.0 pCi/g	0.21 pCi/g
	^{137}Cs, 0.113 pCi/g	0.46 pCi/g

3.1.7 Laboratory Analysis

Soil samples will be collected from the RBAs and sent offsite to an analytical laboratory for various analyses. The analytical methods and the radionuclides being analyzed for are presented in the SAP and are summarized in **Table 3-4**. The SAP provides additional guidance on soil sampling, chain-of-custody, laboratory analysis, and quality assurance/quality control requirements.

Table 3-4. Analytical Sample Summary

Analytical Method	Radionuclide
Gamma Spectroscopy (gamma-emitting ROCs and naturally occurring radionuclides)	^{137}Cs ^{226}Ra (equilibrated; via ^{214}Bi and/or ^{214}Pb) ^{238}U Series (^{238}U via protactinium-234m, ^{214}Pb, ^{214}Bi) ^{232}Th Series (^{228}Ac, ^{212}Pb, ^{212}Bi, ^{208}Tl) ^{40}K ^{241}Am
Alpha Spectroscopy (alpha-emitting ROCs and naturally occurring radionuclides)	^{239}Pu /^{240}Pu ^{241}Am ^{226}Ra Thorium (^{232}Th, ^{230}Th, ^{228}Th) Uranium (^{238}U, ^{235}U, ^{234}U)
Radon Emanation (Lucas Cell) (to support future NORM evaluations)	^{226}Ra
Gas Flow Proportional Counting	^{90}Sr

Notes:

^{208}Tl = thallium-208
^{212}Bi = bismuth-212
^{212}Pb = lead-212
^{214}Bi = bismuth-214
^{214}Pb = lead-214
^{228}Ac = actinium-228
^{228}Th = thorium-228
^{230}Th = thorium-230
^{234}U = uranium-234
^{238}U = uranium-238
^{240}Pu = plutonium-240
^{241}Am = americium-241

3.2 Survey Implementation

Prior to initiating the RBA characterization field activities, several premobilization and mobilization steps will be performed to ensure that work can be performed in a safe and efficient manner.

3.2.1 Premobilization Activities

The primary premobilization tasks include training of field personnel, procurement of support services, and obtaining access to onsite and offsite RBAs. Coordination with the City of San Francisco will be conducted to facilitate access and approval for sampling and ground disturbance activities at McLaren

Park. Sampling at McLaren Park will only be conducted if access and approval are granted. The various support services that are anticipated to be required are as follows:

- Radiological analytical laboratory services
- Drilling subcontractor
- Civil surveying subcontractor
- Utility location subcontractor
- Vegetation clearance subcontractor

3.2.1.1 Training Requirements

Any non-site-specific training required for field personnel will be performed prior to mobilization to the extent practical. Training requirements are outlined in the Parcel G Work Plan and in SOP RP-115, *Radiation Worker Training*, included in the Parcel G Work Plan.

Medical examinations, medical monitoring, and training will be conducted in accordance with the APP/SSHP and Parcel G Work Plan requirements.

3.2.1.2 Permitting and Notification

Prior to initiation of field activities for the radiological investigation, the contractor will notify the Navy Remedial Project Manager (RPM), Resident Officer in Charge of Construction (ROICC), Radiological Affairs Support Office (RASO), and HPNS security as to the nature of the anticipated work. Any required permits to conduct the fieldwork will be obtained prior to mobilization.

The contractor will notify the California Department of Public Health at least 14 days prior to initiation of activities involving the Radioactive Material License (**Section 5**).

3.2.1.3 Pre-Construction Meeting

A pre-construction meeting will be held prior to mobilization of equipment and personnel. The purpose of the meeting will be to discuss project-specific topics, roles and responsibilities of project personnel, project schedule, health and safety concerns, and other topics that require discussions before field mobilization. Representatives of the following will attend the pre-construction meeting:

- Navy (RPM, RASO, ROICC, and others as applicable)
- Contractor (Project Manager, Site Construction Manager, Project Quality Control Manager, PRSO, and Site Safety and Health Officer)
- Subcontractors as appropriate

3.2.2 Site Survey Preparation Activities

The following steps will be implemented to prepare for the sampling activities and to facilitate access to the site:

- Review the applicable activity hazard analyses prior to starting work evolutions.
- Cut brush and weeds (if appropriate) within each RBA to a maximum height of 4 inches to facilitate scanning and sampling activities.
- Locate and mark utilities in the field in accordance with the *Locating and Clearing Underground Utilities* SOP, included in the Parcel G Work Plan.
- Verify that utilities have been deactivated (to the extent possible) and if not deactivated, the active utilities will be further identified and marked to ensure that field personnel understand the exact location and estimated depth. An exclusion area will be placed around the active utilities to prevent accidental exposure to the utility, based on the utility hazard or importance.

  - If utilities are in locations that interfere with planned RBA characterization activities, the area may be relocated, as long as the area remains within the historical RBA footprint.

- Remove debris or obstacles that could obstruct sampling and survey activities. Surface obstructions preventing access will be removed prior to direct-push activities.
- Locate and mark the planned sample locations.

3.2.3 Scan Measurements

Following the completion of the site preparation activities, 100 percent of the accessible surface (i.e., ground level surface) of each RBA will be scanned for gamma activity using one or more of the instruments specified in **Table 3-2** (or equivalent). Both gross gamma and gamma spectral measurements will be collected simultaneously during the gamma scan.

The gamma scans of the accessible surface areas will be performed using a GPS coupled with an appropriate gamma scintillation detector or meter (e.g., Ludlum 44-20 or Bicron 3x5x16/3SSL-X). Along with position, each gamma measurement will be coupled with a date and time stamp. The scans will be performed following a NUREG-1575 protocol by scanning straight lines at a rate of approximately 0.5 m/s in approximately 1-meter-wide swaths, with a consistent detector distance from the ground surface (4 inches above the surface) (USEPA et al., 2000). Generally, each RBA will be gamma scanned as follows (the following description assumes that the RBA is positioned such that the sides align with northern, southern, eastern, and western directions):

- Begin with the detector positioned in the southwestern corner of the RBA at a height of about 4 inches above the surface. Orient the system to face north and initiate data collection (detector is automatically logging radiation readings and GPS is automatically logging position readings) so that the system is recording at a rate of one reading per second (or other, as determined by the project health physicist).
- Move the detector in the northern direction at a not-to-exceed speed of 0.5 m/s.
- Once the detector has reached the edge of the RBA, turn the system around (now facing south) and offset the next detector path by approximately 1 meter (or appropriate based on the instrument's detector size) to allow for a small overlap in the detector field of view
- Move the detector in the southern direction at a not-to exceed speed of 0.5 m/s.
- Repeat these steps until the RBA has been scan surveyed.

Assuming a 2,500-ft^2 (232-square-meter) area for each onsite RBA plus 5,600-ft^2 (520-square-meter) area for the offsite RBA (or smaller as appropriate), a survey as described above moving at a speed of 0.5 m/s should result in the collection of a minimum of 1,450 scan measurements over the five RBAs (assuming 100 percent of each RBA is accessible). Offsite RBA locations are assumed to be radiologically non-impacted and in order to be minimally invasive to park areas, gamma scans may be limited to the immediate vicinity of sample locations instead of the whole RBA. Data will be documented and managed as described in **Section 3.2.8**. Data sets will be transferred from the data logger onto a personal computer to create spreadsheets and geographic information system (GIS)-plotted maps. These data sets will be evaluated in accordance with **Section 4**. Following the scan survey, the number of data points and the percent coverage (from a plot of the data) will be reviewed to ensure that the design parameters of the gamma scan survey were satisfied. If elevated scan measurements are observed, follow-up investigations may be performed with static gamma measurements to delineate and characterize potential areas of interest. Areas with elevated scan measurements that are attributed to contamination or discrete radiological objects will not be sampled, and alternate locations will be selected.

3.2.4 Surface Soil Sampling Process at Onsite and Offsite RBAs

Prior to surface sampling, ensure that the necessary gamma scan measurements have been collected as described in **Section 3.2.3** and reviewed and accepted as described in **Section 4.1**. Surface soil samples will be collected in accordance with the *Soil Sampling* SOP, included in the Parcel G Work Plan. Generally, the surface soil samples will be collected as follows:

- For areas without an asphalt cover, a clean shovel, hand auger, or other tool will be used to remove a small area (about 3 inches in diameter) of soil to a depth of 6 inches. For areas with an asphalt cover, sampling will follow the process described in **Section 3.2.5**
- The removed soil will be transferred directly into a clean stainless steel bowl for mixing.
- The soils removed from the sample location will be visually described in the field logbook in accordance with the *Preparing Field Log Books* SOP, included in the Parcel G Work Plan. Identify the sample as surface soil and include the approximate volume of the extracted soil. Color, moisture, texture, and clast composition (i.e., serpentine, shale, sandstone, chert, gabbro) will be identified.
- The sample for radiological analyses will be mixed in the field by breaking the sample into small pieces and removing overburden gravel and biological material. The entire mixed sample, or aliquot thereof, will be placed in the designated laboratory sample container. A minimum of 200 grams of soil (approximately 1 cup) are required to complete all required analyses, or 400 grams if the sample is selected as a field duplicate.
- When a field duplicate sample is required (1 for every 10 field samples collected), the duplicate sample will be collected following mixing of the material and splitting the aliquot into an additional sample container.
- Samples will be identified, labeled, and cataloged according to **Section 3.2.7**, and then placed into the appropriate sample cooler (if required) for transport to the contract laboratory. Custody of the sample will be maintained according to the *Chain-of-Custody* SOP, included in the Parcel G Work Plan.
- No extra sample material is expected from surface soil sampling because the entire sample will be sent to the laboratory for analysis. Excess soil material that was not sampled will be returned to the hole from which it came or will be spread adjacent to the sample location.
- When possible, disposable sampling equipment will be used because clean, unused materials do not affect sample results. If reusable sampling equipment is used, it will be cleaned between each sampling event as appropriate. Cleaning of sampling equipment will be conducted using SOP RP-112, *Decontamination of Personnel and Equipment*, included in the Parcel G Work Plan.
- If fluids are generated during cleaning of sampling equipment, the fluids will be containerized and sampled for offsite analysis to determine radionuclide concentrations prior to disposal. Other investigation-derived waste (IDW), including used personal protective equipment (PPE) will be radiologically surveyed prior to disposal using SOP RP-105, *Unrestricted Release Requirements*, included in the Parcel G Work Plan.

3.2.5 Subsurface Soil Sampling Process at Onsite RBAs

3.2.5.1 Drilling Area Setup

Prior to the commencement of drilling at the sample location (RBAs 1 through 4), the drill site will be prepared by performing the following:

- Clear overhead obstacles, as necessary, to safely operate the drill rig (minimum of 10 feet of clearance between top of drill boom and obstacles).

- Review and ensure that subsurface clearance has been performed and drilling has been approved (refer to the *Locating and Clearing Underground Utilities* SOP, included in the Parcel G Work Plan).
- If utility or other obstacles prevent safe working conditions, the sample location can be re-located at the discretion of the field team lead. To the extent practical, the new sample location should be moved to a safe location as close to the original planned location, while staying within the 400-ft^2 area.

3.2.5.2 Subsurface Soil Sample Collection

Prior to subsurface sampling, ensure that the necessary gamma scan measurements have been collected as described in **Section 3.2.3** and reviewed and accepted as described in **Section 4.1**. Subsurface soil samples will be collected by following the *Soil Sampling* SOP, included in the Parcel G Work Plan. Subsurface soil samples will be collected using drilling-rig-mounted equipment to collect samples with thin-walled tube sampling or split-spoon sampling. Generally, drilling and retrieving the boring using the thin-walled tube method will be as follows:

- If an asphalt cover exists at the sample locations, the asphalt will be removed to facilitate soil sampling. Following completion of sampling, asphalt cores will be replaced.
- Using a drilling rig, a hole is advanced to the desired depth. The samples are then collected following the ASTM International (ASTM) D 1587 standard.
- The sampler is lowered into the hole so that the sample tube's bottom rests on the bottom of the hole. The sampler is advanced by a continuous, relatively rapid downward motion. The sampler is withdrawn from the soil formation as carefully as possible to minimize disturbance of the sample. To obtain enough volume of sample for subsequent laboratory analysis, use of a 3-inch-internal-diameter sampler may be required.
- Upon removal of the tube from the ground, drill cuttings in the upper end of the tube are removed, and the upper and lower ends of the tube are sealed. The soil tube will be turned over to the project geologist and radiation technician for sample preparation, radiological surveys, and containerization. Once retrieved from the hole, the tube is carefully cut open to maintain the material in the tube.

Generally, drilling and retrieving the boring using the split-spoon sampling method will be performed as follows:

- Using a drilling rig, a hole is advanced to the desired depth. The samples are then collected following the ASTM D 1586 standard.
- The sampler is lowered into the hole and driven to a depth equal to the total length of the sampler; typically, this is 24 inches. The sampler is driven down using a weight ("hammer"). To obtain enough volume of sample for subsequent laboratory analysis, use of a 3-inch-internal-diameter sampler may be required.
- Upon removal of the soil core from the ground, the soil core will be turned over to the project geologist and radiation technician for sample preparation, radiological surveys, and containerization. Once retrieved from the hole, the sampler is carefully split open to maintain the material in the sampler.

Soil tubes and cores will be processed within the background areas; however, because these surveys are performed in reference areas, all locations inside the reference area (not necessarily within the RBA) should be acceptable. One central processing area may be established for the entire investigation, or separate processing areas may be established for each RBA.

Once the soil tube has been cut open or the core has been split open, soil examination and sample collection will occur as follows:

- The geologist will log the soil boring to provide accurate and consistent descriptions of soil characteristics. Soil boring logs will be maintained according to the *Logging of Soil Borings* SOP, included in the Parcel G Work Plan. The geologist will subdivide the soil boring into the 1-foot increments corresponding to the vertical demarcation in the design. Based on observations of the lithologic characteristics, if there is a visible change in soil types in the vertical column, the geologist may modify the proposed depth increments so that a sample volume is representative of a single soil type. The geologist may also recommend that additional samples be collected to adequately represent the observed soil types.
- The sample for radiological analyses will be mixed in the field by breaking the sample into small pieces and removing gravel. The depth, recovery position, and scan measurement information should be correlated to each sample extracted from the core.
- A minimum of 200 grams of soil (approximately 1 cup) are required to complete the analyses, or 400 grams if the sample is selected as a field duplicate. If sample size requirements are not met by a single sample collection, additional sample volume may be obtained by collecting a sample from below the original sample location within the core and compositing the sample.
- The entire mixed sample will be placed in the designated laboratory sample container and the range of soil depths included in the sample recorded in the field logbook.
- Samples will be identified, labeled, and cataloged according to **Section 3.2.67**, and then placed into the appropriate sample cooler (if required) for transport to the contract laboratory. Custody of the sample will be maintained according to the *Chain-of-Custody* SOP, included in the Parcel G Work Plan.
- When a field duplicate sample is required (1 for every 10 field samples collected), the sample will be evenly split following mixing of the material and removal of extraneous material, and each aliquot placed into an appropriately labeled sample container.
- Excess soil material will be returned to the hole from which it came or will be managed in accordance with Section 7 in the Parcel G Work Plan.
- When possible, disposable sampling equipment will be used because clean, unused materials do not affect sample results. If reusable sampling equipment is used, it will be cleaned between each sampling event as appropriate. Cleaning of sampling equipment will be conducted using SOP RP-112, *Decontamination of Personnel and Equipment*, included in the Parcel G Work Plan.
- If fluids are generated during cleaning of sampling equipment, the fluids will be containerized and sampled for offsite analysis to determine radionuclide concentrations prior to disposal. Other IDW, including used PPE, will be radiologically surveyed prior to disposal using SOP RP-105, *Unrestricted Release Requirements*, included in the Parcel G Work Plan.
- Depth intervals that are not identified as samples or sent for analysis will be returned to the borehole or spread on the ground adjacent to the borehole.

3.2.6 Subsurface Soil Sampling Process at Offsite RBA

To minimize the impact of the characterization on the offsite RBA (RBA-McLaren), subsurface samples will be collected from the 1- to 2-foot bgs interval using hand tools. Prior to subsurface sampling, ensure that the necessary gamma scan measurements have been collected as described in **Section 3.2.3**, and reviewed and accepted as described in **Section 4.1**, and that the surface soil sample has been collected from the top 6 inches of soil. Subsurface soil samples will be collected in accordance with the *Soil*

Sampling SOP, included in the Parcel G Work Plan. Generally, the subsurface soil sample will be collected as follows:

- A clean shovel, hand auger, or other tool will be used to remove a small area (about 3 inches in diameter) of soil to a depth of 1 foot bgs. The removed soil will be placed adjacent to the sample location.
- A clean shovel, hand auger, or other tool will be used to remove a small area (about 3 inches in diameter) of soil from the 1- to 2-foot bgs depth.
- The removed soil will be transferred directly into a clean stainless steel bowl for mixing.
- The soils removed from the sample location will be visually described in the field logbook in accordance with the *Preparing Field Log Books* SOP, included in the Parcel G Work Plan. Identify the sample as surface soil and include the approximate volume of the extracted soil. Color, moisture, texture, and clast composition (i.e., serpentine, shale, sandstone, chert, gabbro) will be identified.
- The sample for radiological analyses will be mixed in the field by breaking the sample into small pieces and removing overburden gravel and biological material.
- A minimum of 200 grams of soil (approximately 1 cup) are required to complete the analyses, or 400 grams if the sample is selected as a field duplicate. If sample size requirements are not met by a single sample collection, additional sample volume may be obtained by collecting a sample from below the original sample location within the core and compositing the sample.
- The entire mixed sample, or aliquot thereof, will be placed in the designated laboratory sample container.
- When a field duplicate sample is required (1 for every 10 field samples collected), the duplicate sample will be collected following mixing of the material and splitting the aliquot into an additional sample container.
- Samples will be identified, labeled, and cataloged according to **Section 3.2.6**, and then placed into the appropriate sample cooler (if required) for transport to the contract laboratory. Custody of the sample will be maintained according to the *Chain-of-Custody* SOP, included in the Parcel G Work Plan.
- Excess soil material will be returned to the hole from which it came or will be spread adjacent to the sample location.
- When possible, disposable sampling equipment will be used because clean, unused materials do not affect sample results. If reusable sampling equipment is used, it will be cleaned between each sampling event as appropriate. Cleaning of sampling equipment will be conducted using SOP RP-112, *Decontamination of Personnel and Equipment*, included in the Parcel G Work Plan.
- If fluids are generated during cleaning of sampling equipment, the fluids will be containerized and sampled for offsite analysis to determine radionuclide concentrations prior to disposal. Other IDW, including used PPE, will be radiologically surveyed prior to disposal using SOP RP-105, *Unrestricted Release Requirements*, included in the Parcel G Work Plan.

3.2.7 Sample Identification

Each surface and subsurface sample will be uniquely identified at the time of collection by the geologist or radiation technician. Samples will be identified as explained in this section.

Sample identifications will use the following format:

AABBBB-CCDD-EEFF-MMYY

Where: AA = facility (HP for Hunters Point will be used in this work plan).

BBBB = site location (RBAs 1 through 4 = RBA1, RBA2, RBA3, RBA4; RBA-McLaren = RBAM).

CC = sample type (options include SS for surface sample or SB for subsurface sample).

DD = sample location number (within each RBA there will be 01 to 25 sample locations; duplicate locations will be assigned the letter "P" after this number [DDP]).

EEFF = two-digit sample interval in feet bgs (EE feet = top of sample interval and FF feet = bottom of sample interval). EE and FF are whole numbers such that a value of "01" represents "1-foot bgs." Surface samples (samples collected from the 0.0- to 0.5-foot bgs depth interval) will be designated as 000H; H is for half foot. If the surface sample is collected from a depth other than a half foot, the H designation will still be used; however, a note will be included in the field book to indicate the actual depth sampled.

MMYY = two-digit month (MM) and two-digit year (YY) corresponding to the collection month and year. Example for a sample collected in June of 2018 is MMYY = 0618.

For example, a surface soil sample collected from RBA-1 at sample Location 1 in March 2018 will be identified as follows:

HPRBA1-SS01-000H-0318

In this example, "HPRBA1" identifies Hunters Point Reference Background Area 1. "SS01" identifies the sample as a surface sample collected at sample location 01. "000H" represents the depth interval for a surface sample (000H is the agreed-upon code established for surface samples as explained above).

For example, a subsurface sample collected from RBA-4 at sample Location 5 from the 9- to 10-foot bgs interval in April 2018 will be identified as follows:

HPRBA4-SB05-0910-0418

A duplicate sample collected from the sample location will be identified as follows:

HPRBA4-SB05P-0910-0418

An example of a surface sample collected from RBA-McLaren at sample Location 12 in June 2018 will be identified as follows:

HPRBAM-SB12-000H-0618

3.2.8 Documentation and Sample Shipping

Samples will be documented in accordance with the general requirements in the *Preparing Field Log Books* and the *Chain-of-Custody* SOPs, included in the Parcel G Work Plan. These SOPs identify the requirements for sample labels, custody seals, and chains-of-custody. A digital sample documentation/tracking program may be used during the execution of the work plan to provide additional confidence in sample recordkeeping and to add efficiencies to the process.

Samples will be packaged and shipped for offsite analysis in accordance with the *Packaging and Shipping Procedures for Low-Concentration Samples* SOP, included in the Parcel G Work Plan.

Radiological surveys will be performed and documented in accordance with SOP RP-106, *Survey Documentation and Review*, included in the Parcel G Work Plan. Sample collection, field measurements, and laboratory data will be recorded electronically to the extent practicable. Electronically recorded data and information will be backed up to a SharePoint site or equivalent on a nightly basis, or as reasonably practical. Data and information recorded on paper will be recorded using indelible ink. Both electronic and paper records of field-generated data will be reviewed by the PRSO or a designee knowledgeable in the measurement method for completeness, consistency, and accuracy. Data manually transferred to paper from electronic data collection devices will be compared to the original data sets to ensure consistency and to resolve noted discrepancies. Electronic copies of original electronic data sets will be preserved on a nonmagnetic retrievable data storage device. No data reduction, filtering, or modification will be performed on the original electronic versions of data sets.

SECTION 4

Data Evaluation and Reporting

Various types of radiological data are being collected from multiple RBAs during the execution of this work plan, from soils with potentially different distributions of naturally occurring and fallout radionuclides. Gamma scan data will be mapped and evaluated as detailed in **Section 4.1**. Analytical data (i.e., soil sample results) will be compiled and validated in accordance with the SAP. Following data validation, analytical sample results will be evaluated as detailed in **Section 4.2**. Following evaluation, the RBA characterization data will be compiled and submitted in a Soil RBA Report as detailed in **Section 4.4**.

4.1 Gamma Scan Data Evaluation

Gamma scan survey data from each RBA will be initially evaluated as individual RBA data sets for both gross gamma and gamma spectra. The purposes of the data evaluation are the following:

- Conduct a preliminary data review and compile basic statistics
- Perform graphical data review
- Identify outliers or data that are not representative of background conditions

4.1.1 Conduct a Preliminary Data Review

The spectra will be analyzed using regions of interest for known gamma-emitting ROCs and naturally occurring radionuclides. Radionuclide-specific (spectra) and gross gamma data set information will be gleaned by compiling basic statistics, including mean, median, minimum, maximum, and standard deviation, and by creating plots such as histograms, box plots, and normal probability plots from each RBA.

Because position measurements were collected in conjunction with the radiological readings, gamma survey maps will be generated using the GPS locations to visually evaluate the geospatial measurements and to confirm the RBA classifications as being non-impacted and suitable for use as RBAs. The gamma survey map will be created as follows:

- Using GIS software, the gamma measurement will be spatially plotted using the GPS coordinates recorded during the scan survey.
- Measurements collected outside of the RBA footprints will be digitally cropped out of the survey maps so that only the designated RBAs will contain gamma measurements.
- Using kriging functions in GIS, a contiguous surface will be created and color-coded for visualization of the readings.

4.1.2 Identify Outliers

The gamma scan survey data will undergo an outlier evaluation using Dixon's and Rosner's outlier tests. Dixon's test is valid for data sets with up to 25 data points while Rosner's test is recommended for larger data sets. Details of Dixon's and Rosner's tests for outliers are provided in **Section 4.2.2**. Both Dixon's and Rosner's tests assume that the data values (aside from those being tested as potential outliers) are normally distributed. Because environmental data tend to be right-skewed, a test that relies on an assumption of a normal distribution may identify a relatively large number of mathematical outliers. Outliers identified in this evaluation will be reviewed to determine that the outliers are attributable to elevated radioactivity or find out if any other causes (e.g., a potential electronics error) exist. If elevated scan measurements are observed, follow-up investigations may be performed with static measurements to delineate and characterize potential areas of interest. Areas with elevated scan measurements that are attributed to contamination or discrete radiological objects will not be sampled, and alternate locations will be selected.

4.2 Analytical Data Evaluation

A statistical data evaluation will be conducted to identify appropriate soil background data sets and calculate descriptive statistics to facilitate future comparisons with site-specific data. The purposes of the data evaluation are the following:

- Conduct a preliminary data review, which includes the following tasks:
  - Compile basic statistics
  - Perform graphical data review
- Identify outliers or data that are not representative of background conditions.
- Conduct statistical tests, including determining statistical differences between data sets.
- Review equilibrium conditions of naturally occurring radionuclides.

4.2.1 Conduct a Preliminary Data Review

Analytical data set information will be reviewed by compiling basic statistics, including mean, median, minimum, maximum, and standard deviation. Graphical comparisons will be made using posting plots, histograms, box-and-whisker plots, quantile-quantile plots, and normal probability plots from each RBA. Review of the basic statistics and plots will provide useful information, such as revealing homogeneity or heterogeneities, spatial trends, data distributions, and skewness. RBA data from individual RBAs are assumed to follow a normal or log-normal distribution without bi-modalities or skewness. The results of the normality testing can be used to validate a data set as being consistent with assumptions concerning background.

4.2.2 Identify Outliers

Graphs of analytical data will be reviewed for indications of data values outside of the expected distribution (i.e., potential outliers). In addition, outlier evaluations will be performed using Dixon’s and Rosner’s tests or other appropriate tests, including non-parametric methods. Dixon’s test is valid for data sets with up to 25 data points while Rosner’s test is recommended for larger data sets. Both Dixon’s and Rosner’s tests assume that the data values (aside from those being tested as potential outliers) are normally distributed. Both statistical outlier tests will be performed using statistical software or spreadsheets and are described here. The Dixon test will be performed by arranging the concentrations of a specific nuclide in ascending order from X_1 to X_N and using **Equation 4-1**:

Equation 4-1

$$Q_{exp} = \frac{X_2 - X_1}{X_N - X_1}$$

Where:

Q_{exp} = experimental Q-value

X_N = highest value of measurements

X_1 = value of smallest measurement

X_2 = value of second smallest measurement

The corresponding Q_{exp} value is compared to the critical value (Q_{crit}) obtained from a confidence level of 95 percent.

Because Dixon's test is appropriate for samples sizes with up to 25 data points, Rosner's test for outliers will be performed for sample sizes larger than 25. The Rosner's test is performed as follows:

- Arrange the concentrations of a specific nuclide in ascending order, and by simple inspection, identify the maximum number of possible outliers r_0.
- Compute the mean and standard deviation of the data and determine the measurement furthest from the mean.
- Delete the measurement from the data set and compute the sample mean and standard deviation from the remaining observations. Again, find the value in the reduced data set furthest from the mean.
- Delete the measurement and recompute the mean and standard deviation until all potential outliers have been removed.
- Perform test for outliers, using **Equation 4-2**:

Equation 4-2

$$R_{r-1} = \frac{\left|y^{(r-1)} - \bar{x}^{(r-1)}\right|}{s^{(r-1)}}$$

Where:

R_{r-1} = test statistic for potential *r* outlier

$y_{(r-1)}$ = measurement value of outlier

$x_{(r-1)}$ = mean of reduced data set without $y_{(r-1)}$ value

$s_{(r-1)}$ = standard deviation of reduced data set with $y_{(r-1)}$ value

- Compare the test statistic (R_{r-1}) to the critical value corresponding to a confidence level of 95 percent.
- Perform the test statistic for the other possible outliers identified in Step 1 in the same fashion until the possible outliers have either been identified or Rosner's test finds no outliers.

Because environmental data tend to be right-skewed, a test that relies on an assumption of a normal distribution may identify a relatively large number of mathematical outliers. Outliers identified in this evaluation will be reviewed to determine whether any suitable reasons (e.g., a potential analytical error) exist to exclude them from further calculations. Confirmed outliers will be removed from individual data sets.

4.2.3 Conduct Statistical Tests

Background concentrations from each RBA for surface soil and subsurface soil will be compared statistically to test for differences between surface soil and subsurface soil concentrations and to test for differences among soil types. If the data sets are not significantly different, then they will be combined to create a larger background data set. If the data sets are significantly different, then they will be treated separately for comparisons of site-specific data to background.

In addition to graphical inspection, central tendency comparisons will be performed to determine whether the centers of the distributions of the surface soil and subsurface soil data, and between the various soil types, are different or similar. Statistical tests for a normal distribution (symmetry) will be performed using computer software to conduct the Shiparo-Wilk/Lillifors testing for normality.

The RBA data sets will be compared to each other by applying the KW statistical test, detailed in Section 13.2 of NUREG-1505 (NRC, 1998a) to determine whether the reference areas have similar or significantly different background levels. If data sets are similar (i.e., pass the KW test), they may be combined. If data sets are significantly different (i.e., fail the KW test), further evaluation will be performed to determine the potential causes of the differences, such as soil type or depth bgs. Data may be plotted on site maps or plotted against gamma-scan data to look for visual clues as to ROC distribution and to evaluate spatial independence.

4.2.4 Review Equilibrium Conditions

The RBA data sets for ^{226}Ra and other naturally occurring ROCs will be selected to represent as much of the soil at HPNS as practical. However, the history of HPNS shows that a wide variety of fill materials have been used as part of construction and maintenance activities over the life of the site. These fill materials may have a wide range of naturally occurring radioactivity and could result in an incorrect identification of fill material with higher levels of NORM being identified as contamination. To avoid this situation, the Navy may perform additional evaluation of investigation samples where the ^{226}Ra gamma spectroscopy result exceeds the RG and the expected range of background but could still be associated with NORM instead of contamination.

The uranium natural decay series is one of the primordial natural decay series that are collectively referred to as NORM. The members of the uranium natural decay series are present in background at concentrations that are approximately equal, a situation referred to as secular equilibrium. Secular equilibrium for the uranium natural decay series is established over hundreds of thousands of years. Concentrations of ^{226}Ra higher than the concentrations of other members of the uranium natural decay series may indicate contamination, while ^{226}Ra concentrations consistent with other members of the series indicate natural background.

Determining the equilibrium status of the uranium natural decay series requires analyzing a sample for multiple radionuclides from the series using the same or comparable analytical techniques. Observed differences in concentrations result primarily from differences in concentrations, and the uncertainty is primarily associated with the analysis.

Radionuclides from the uranium natural decay series with ^{226}Ra as a decay product (i.e., ^{238}U, ^{234}U, and ^{230}Th) will be analyzed by alpha spectroscopy, along with ^{226}Ra. It is not necessary to analyze for the decay products of ^{226}Ra because these radionuclides re-establish secular equilibrium with ^{226}Ra over a period of several weeks. In addition, most of the ^{226}Ra decay products are not readily analyzed by alpha spectroscopy.

Alpha spectroscopy will be performed for uranium isotopes (^{238}U, ^{235}U, ^{234}U), thorium isotopes (^{232}Th, ^{230}Th, and ^{228}Th), and ^{226}Ra. If practical, the analyses will be performed using the same sample aliquot to reduce sampling uncertainty. The results of the four analyses will be compared, and the ratio between the ^{226}Ra and the other three radionuclides will be calculated to evaluate whether the radionuclides are in secular equilibrium.

4.2.5 Establish Background Data Sets

Once a determination has been made about combining data from the RBAs, one or more RBA data sets for each radionuclide will be established. Pending approval for their use, the data sets will be used for comparison with trench or surface soil data sets as described in the Parcel G Work Plan.

While the focus of the analytical evaluation will be on radioactivity, the evaluations may also identify and record relationships and correlations between lithologic characteristics of the samples and the radioactivity.

4.3 Review of Other RBA Data Sources

The history of HPNS shows that a wide variety of fill materials have been used as part of construction and maintenance activities over the life of the site. These fill materials may have a wide range of naturally occurring radioactivity. In order to gain a more comprehensive understanding of background conditions, previous offsite background studies that have been performed in and around the Bay Area over the past 20 years will be evaluated. Studies performed by the U.S. Geological Survey (USGS) (Bouse et al., 2010; Fuller et al., 1998; Nilsen et al., 2015; Higgins et al., 2007), Navy, and Lawrence Berkeley National Lab, among others, will be evaluated to determine whether the data may be comparable or representative of materials at HPNS. Review of the available information from the offsite studies will include analytical results of ROCs and NORM constituents, analytical methods, soil lithology, and geographic latitude.

4.4 Reporting

Following completion of RBA soil data evaluation, a report will be prepared to include a summary of the field activities, any deviations from the work plan, results of gamma scan surveys, and analytical and geotechnical data (including full data packages from the analytical laboratory and third-party validation reports), along with the results of the data evaluation. Based on the statistical evaluations, the report will include recommendations for combining similar data sets, and recommendations for selecting values or data sets representing background in soil, and conditions identifying situations when specific values or data sets may not be appropriate. Information from other San Francisco Bay Area radiological background studies may be referenced in the report as appropriate. If additional areas are selected for sampling, if other background data sets are identified, or if USGS is involved and provides input, details and justification will be provided in the report. The draft report will be submitted for regulatory review, and meetings will be held to discuss the results and facilitate consensus on appropriate background values prior to finalizing the report.

SECTION 5

Radioactive Materials Management and Control

This work plan was prepared based on CH2M HILL, Inc. (CH2M) and its subcontractor, Perma-Fix, leading and conducting the field activities presented in this work plan. Prior to initiating field activities at HPNS, Perma-Fix will invoke their Radioactive Material License, as described in the Parcel G Work Plan. The Parcel G Work Plan includes the following contractor-specific information: Radioactive Material License, SOPs, Organizational Chart, and Radiation Protection Plan. The APP/SSHP outlines the health and safety requirements and procedures for the field activities included in this work plan.

SECTION 6

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Responses to Comments
Draft Final Parcel G Removal Site Evaluation Work Plan
Former Hunters Point Naval Shipyard, San Francisco, California

The purpose of this document is to address comments on the Draft Parcel G Removal Site Evaluation Work Plan, dated November 2018, for Former Hunters Point Naval Shipyard, San Francisco, California. The United States Environmental Protection Agency (USEPA) comments received December 13, 2018 and Department of Toxic Substances Control (DTSC) and California Department of Public Health (CDPH) received December 14, 2018 are listed below and responses to comments are provided in bold. The work plan will be updated to address these comments and a final version submitted.

USEPA Comments

Evaluation of the Responses to Comments

1. Responses to EPA General Comments 10 and 11 and Appendix C Soil Reference Background Area Work Plan Section 3.1.6.4, Example Gamma Scan Minimum Detectable Concentrations: The responses partially address the comments. The responses refer to the example minimum detectable concentration (MDC) calculations provided in the Work Plan Section 3.5.2.3 (Example Gamma Scan Minimum Detectable Concentrations); however, the calculations include assumptions in identifying the gamma scan achievable MDC of 0.93 picoCuries per gram (pCi/g) for radium-226 (Ra-226) and 2.3 pCi/g for cesium-127 (Cs-137) using a Ludlum 44-20 detector and MDCs of 0.21 pCi/g for Ra-226 and 0.46 pCi/g for Cs-137 using a Bicron 3SSL-X. The following clarifications will make the text more accurate and complete:

    a. The MDC calculations assume a background level of 18,000 counts per minute (cpm) with 95 percent correct detections and 95 percent (%) false positive rates resulted in a d’ of 3.28. However, the calculations were performed assuming a 95% chance of correct detections and a 5% chance of false positives. Please revise the text to correct the reference of 95% false positives to 5%.

       The typo will be corrected in Section 3.5.2.3.

    b. The MDC calculations assume a surveyor efficiency of 100% using an automated data logger. Because of the variability of scan speed and distance from the detector to the surface inherent in human operation of such equipment, the efficiency of 100% is often considered to be not achievable. Please revise the text to explain how a 100% efficiency can be achieved or to correct this estimate to a percentage achievable by operators.

       For surveys utilizing logging equipment and post-processing, it is common to use a surveyor efficiency of 1. As described in NUREG-1507 Section 6.7, estimated values for surveyor efficiency in the 0.5 to 0.75 range are based on the surveyor’s ability to respond to instrument audio response and decide when a measurement requires further investigation. The variability of scan speed and detector distance are not factors in that variable. When using a data logger and post-processing, the surveyor no longer has a decision in determining when investigation is necessary. Therefore, it is reasonable to set a value of 1 to the surveyor efficiency when a data logger is used.

c. The contaminated zone is assumed to be present in a circular area over 1 meter squared with a depth of 15 centimeters (cm); however, Ra-226 or Cs-137 contamination, if it exists, may not be present in an evenly distributed circular area over 1 m2 and 15 cm deep. Therefore, detection of discreet locations of Ra-226 or Cs-137 at or below the remedial goals (RGs) using the gamma scanning may not be realistically achievable. Please revise the text to acknowledge that contamination in this configuration may not be detectable.

The text in the last paragraph of Section 3.5.2.3 will be updated to read as follows (new text is underlined): "… a concentration of 0.113 pCi/g. <u>Note that the measurement geometry and parameters modeled are meant to illustrate an assumption for the calculation. Contamination, if present, may not exist in the same modeled configuration, and the modeled scan MDCs may not apply.</u>"

d. The MDC for the gamma instrument RS-700 is listed as 0.036 pCi/g, but the calculation for this MDC is not provided. Please revise the Work Plan to include this calculation.

Additional information about the RS-700 referenced in Section 3.5.2 will be provided by the Parcel G soil contractor (Aptim) in an addendum to the work plan.

2. Response to EPA General Comment 10: The response partially addresses the comment. Table 3-7 (A Priori Scan MDCs) does not list the Scan MDCs for the soil sorting system. Please provide this information prior to finalizing the Draft Final Work Plan, if the sorting system will be used.

   Implementation of the soil investigation outlined in this work plan will be performed by a separate contractor. A soil sorting operations plan will be provided by the Parcel G soil contractor prior to the start of soil handling operations and after the final work plan is issued. The soil sorting operations plan will contain the scan MDCs.

3. Response to EPA General Comment 15, item a: The response addresses the comment. Please also revise Figure 4-4, Building 366 Floor Plan, to include the Class 3 Survey Unit (SU) #69.

   A note will be added to work plan Figure 4-4 and SAP Figure 11-7 to state, "SU 69 consists of the building exterior surfaces."

4. Response to EPA General Comment 15, item b: The response partially addresses the comment. Section 3.7 (Radiological Laboratory Analysis) states that analyses will be based on the site-specific radionuclides of concern (ROCs) as listed in Table 3-4. According to Table 3-4, the ROCs associated with Buildings 317/364/365 site include Cs-137, Ra-226, Sr-90, and Pu-239. In addition, please see the Historical Radiological Assessment (HRA) and the information provided in Section 2, the Conceptual Site Model (CSM), which show additional ROCs. The exception is Cobalt 60. EPA previously wrote the following: "Cobalt 60 (Co-60): The Navy ceased Shipyard operations in 1974, 42 years ago. The half-life of Co-60 is 5.26 yrs. After seven to ten half-lives (i.e., 37 to 53 years), remaining radiological activity would be at levels similar to background. Therefore, Co-60 is not a priority health and safety concern, and any Co-60 sampling conducted would not be a helpful indicator of potential prior falsification." According to the HRA and CSM, for Building 364, uranium-235 (U-235) is also a ROC; for Building 365, U-235 is also a ROC; for Building 351, thorium-232 (Th-232) is an ROC in addition to Cs-137, Ra-226, and Sr-90; and for Building 351A, plutonium-239 (Pu-239), Ra-226 and Th-232 are also ROCs. For consistency

please revise Section 3.7 to include analyzing all samples for all ROCs, except Co-60, from current and former building areas where the HRA indicates those ROCs were used. For instance, Section 3.7 includes the following rules regarding analysis requirements:

a. At the former Buildings 317/364/365 where Pu-239 is an ROC, at least 10 percent of randomly selected systematic soil samples will be analyzed by alpha spectroscopy for Pu-239.

b. At least 10 percent of randomly selected samples will be analyzed by gas flow proportional counting for Sr-90.

c. If laboratory results indicate a concentration of Strontium-90 (Sr-90) above the RG in a sample, the sample will be analyzed via alpha spectroscopy for Pu-239.

As such, the Draft Final Work Plan should be revised to state that all samples should be analyzed for all ROCs that are applicable to a particular building or building site (except Co-60). In addition, soil samples from all SUs and trench units (TUs) in the vicinity of and downstream of these sites and buildings should also be analyzed for all of ROCs associated with that building or building site (excerpt Co-60). Please revise the Draft Final Work Plan to include these requirements. Please also revise the Draft Work Plan to include analyzing samples from SUs/TUs immediately surrounding and downstream of these building areas for all identified associated ROCs.

Also, Section 4.2 (Radionuclides of Concern) and Table 4-1 (Building Radionuclides of Concern), list Th-232 as a ROC for Building 408 (demolished). Please revise the Draft Final Work Plan to ensure that samples from surrounding or downstream SUs and TUs are analyzed for all ROCs identified for an existing or former building.

The text in Section 3.7 will be updated to include the following:

- **At the Former Buildings 317/364/365 Site and adjacent TUs 95, 117, 118, and 153 (Figure 3-1), where ^{239}Pu and ^{235}U are ROCs, at least 10 percent of randomly selected systematic soil samples will be analyzed by alpha spectroscopy for ^{239}Pu and ^{235}U.**
- **At the Building 351A Crawl Space and adjacent TUs 115 and 97 (Figure 3-1), where ^{239}Pu and ^{232}Th are ROCs, at least 10 percent of randomly selected systematic soil samples will be analyzed by alpha spectroscopy for ^{239}Pu and ^{232}Th.**
- **At TUs 107 and 116 (Figure 3-1), adjacent to Building 408 where ^{232}Th was an ROC, at least 10 percent of randomly selected systematic soil samples will be analyzed by alpha spectroscopy for ^{232}Th.**

5. Response to EPA General Comment 15c: The response states “the RGs are not based on the same dose or risk. Therefore, the use of sum of fractions and unity rule to review total risk is not appropriate for this approach.” That is true. Therefore, instead, if have multiple ROCs are present above background concentrations in one location, the Work Plan should include an evaluation to ensure the combined residual risk does not exceed 1X10^-4. This evaluation should apply the current version of the EPA PRG Calculator using inputs, assumptions, and approaches supported by regulatory agencies, as described in the forthcoming final version of the Fourth Five Year Review.

Comment noted.

6. Response to EPA General Comment 19: The response partially addresses the comment. Section 3.7 (Radiological Laboratory Analysis) and Section 5 (Data Evaluation and Reporting) still state that if the gamma spectroscopy laboratory results indicate a concentration of Ra-226 above the RG, the sample will be analyzed using alpha spectroscopy for U-238, U-234, Th-230, and Ra-226. Please include all of the uranium and thorium isotopes reportable by alpha spectroscopy. This section and all other sections and figures (i.e. Figure 3.2, Performance Criteria for Demonstrating Compliance with the Parcel G ROD) in the Draft Final Work Plan and the Sampling and Analysis Plan (SAP) (i.e. Worksheets 11 and 15) that list the uranium and thorium isotopes that will be reported for site samples should be revised to list all of the uranium and thorium isotopes reportable by alpha spectroscopy. For consistency and completeness, please revise the Draft Final Work Plan to include the requirement to analyze and report uranium isotopes U-238, U-235, and U-234 and thorium isotopes Th-232, Th-230, and Th-228 by alpha spectroscopy in all relevant sections and figures.

   The following sections will be updated to clarify U-238, U-235, and U-234 and Th-232, Th-230, and Th-228 will be reported for all alpha spectroscopy samples analyzed.

   Work Plan:
   The second sub-bullet under the second bullet under Step 6 of Section 3.1 has been revised to read as follows (new text underlined): "If any ^{226}Ra gamma spectroscopy concentration exceeds the ^{226}Ra RG and the range of expected NORM concentrations, then the soil sample will be analyzed <u>using alpha spectroscopy for uranium isotopes (^{238}U, ^{235}U, and ^{234}U), thorium isotopes (^{232}Th, ^{230}Th, and ^{228}Th)</u>, and ^{226}Ra to evaluate equilibrium conditions."

   The first sub-bullet under the first bullet in Section 3.7 has been revised to read as follows (new text underlined): "…– If the gamma spectroscopy laboratory results indicate a concentration of ^{226}Ra above the RG in a sample, the sample will be analyzed using alpha spectroscopy for <u>uranium isotopes (^{238}U, ^{235}U, and ^{234}U), thorium isotopes (^{232}Th, ^{230}Th, and ^{228}Th),</u> and ^{226}Ra to evaluate equilibrium conditions. Additional…"

   The last sub-bullet on Page 5-1 in Section 5 has been revised to read as follows (new text underlined): "Samples with gamma spectroscopy results that exceed the RG and the expected range of background for ^{226}Ra will be analyzed <u>by alpha spectroscopy</u> for <u>uranium isotopes (^{238}U, ^{235}U, ^{234}U), thorium isotopes (^{232}Th, ^{230}Th, and ^{228}Th),</u> and ^{226}Ra to evaluate the equilibrium status of the uranium natural decay series to determine whether ^{226}Ra is NORM as described in Section 5.6."

   SAP (Appendix B):
   The applicable bullet in Step 6 in Worksheet 11 has been revised to read as follows (new text underlined): "If any ^{226}Ra gamma spectroscopy concentration exceeds the ^{226}Ra RG and the range of expected NORM concentrations, then the soil sample will be analyzed <u>using alpha spectroscopy for uranium isotopes (^{238}U, ^{235}U, and ^{234}U), thorium isotopes (^{232}Th, ^{230}Th, and ^{228}Th)</u>, and ^{226}Ra to evaluate equilibrium conditions."

   The applicable bullet in Step 7 in Worksheet 11 has been revised to read as follows (new text underlined): Gamma spectroscopy data will be reported by the laboratory after a full 21-day in-growth period. If the laboratory results indicate a concentration of ^{226}Ra above the RG

(Worksheet #15a), the sample will be analyzed using alpha spectroscopy for uranium isotopes (^{238}U, ^{235}U, ^{234}U), thorium isotopes (^{232}Th, ^{230}Th, and ^{228}Th), and ^{226}Ra.

Worksheet 17 has been revised to read as follows (new text underlined): "…the sample will be analyzed using alpha spectroscopy for uranium isotopes (^{238}U, ^{235}U, and ^{234}U), thorium isotopes (^{232}Th, ^{230}Th, and ^{228}Th), and ^{226}Ra."

RBA Work Plan (Appendix C):
The last paragraph of Section 4.2.4 has been revised to read as follows (new text underlined): "Alpha spectroscopy will be performed for uranium isotopes (^{238}U, ^{235}U, ^{234}U), thorium isotopes (^{232}Th, ^{230}Th, and ^{228}Th), and ^{226}Ra."

7. Response to SAP General Comments 1: The response addresses the comment. In addition, please fully implement it in the Appendix B SAP. Specifically, the Soil Investigation section of Worksheet #17 states, "Evaluation of the results of Phase 1 may lead to re-excavation of Phase 2 TUs if contamination is identified in Phase 1 trenches." To make Worksheet #14 and #17 more clear to the reader, please include a firm commitment to excavate 100 percent (%) of the Phase 2 TUs if contamination is found in any Phase 1 TU in both Worksheets.

   Worksheets 14 and 17 will be updated to include the following sentence, "The Navy will re-excavate 100 percent of Phase 2 TUs if contamination is identified in Phase 1 TUs.".

8. Response to SAP General Comment 6: The response addresses the comment, and to be more clear to the reader, please revise Worksheet #17 to discuss investigation and remediation of contamination, similar to the approach discussed in Worksheet #11.

   Text will be added to Worksheet 17 to state, "An in situ investigation and/or remediation of the trench sidewalls and floor will be performed prior to backfill."

9. Response to SAP General Comments 7, 8 and 14, items d and p: The responses address the comments, and to be more clear to the reader, please revise Worksheet #11, Step 6 to state that isotopic analyses for uranium isotopes U-238, U-235, and U-234; thorium isotopes Th-232, Th-230, and Th-228; as well as Ra-226 will be analyzed by alpha spectroscopy for performing background evaluations to identify whether detections of Ra-226 in site samples are the result of Naturally Occurring Radioactive Material (NORM) or site sources/contamination.

   The applicable bullet in Step 6 in Worksheet 11 has been revised to read as follows (new text underlined): "If any ^{226}Ra gamma spectroscopy concentration exceeds the ^{226}Ra RG and the range of expected NORM concentrations, then the soil sample will be analyzed using alpha spectroscopy for uranium isotopes (^{238}U, ^{235}U, and ^{234}U), thorium isotopes (^{232}Th, ^{230}Th, and ^{228}Th), and ^{226}Ra to evaluate equilibrium conditions." Additional text revisions are described in the response to comment 6 above.

10. Response to SAP General Comment 14 item h: The response partially addresses the comment. To fully address the comment, please revise the Draft Final Work Plan and SAP to include the soil sorting system detector specifications and ensure that a Soil Sorting Operations Plan is submitted to the regulatory agencies prior to finalizing the Parcel G Work Plan.

    Implementation of the soil investigation outlined in this work plan will be performed by a separate contractor. A soil sorting operations plan will be provided by the Parcel G soil

contractor prior to the start of soil handling operations and after the final work plan is issued. The soil sorting operations plan will contain the detector specifications.

11. Response to SAP General Comment 14, item o: The response partially addresses the comment. The comment requested the SAP be revised to specify that background data sets be evaluated using non-parametric statistical tests to evaluate population estimators. The response states that graphs of analytical data will be reviewed for indications of data values outside of the expected distribution (i.e., potential outliers) and will evaluate potential outliers using the Dixon's and Rosner's tests or other appropriate tests, including non-parametric methods. Please recall that the Dixon's and Rosner's tests are only appropriate for normally distributed data sets. To fully address the comment, please revise the Draft Final Work Plan and SAP to state that data set distributions will be tested for normality and/or non-parametric statistical tests will be used for all evaluations if normality is not confirmed. Please also revise the SAP to include other non-parametric tests for calculating the mean and standard deviation, or to identify outliers.

    Steps 5 and 6 in Worksheet 11 will be updated to clarify that tests for outliers will include, "(other appropriate tests, including non-parametric methods)".

<u>New General Comments</u>

1. The Draft Final Work Plan, Section 2 Conceptual Site Model, Footnote 3 states that comparisons between the onsite laboratory screening results and the offsite laboratory definitive results for Ra-226 demonstrate that the onsite laboratory results were consistently biased high and resulted in false exceedances of the RGs and that remediation may have been avoided had decisions been based on the off-site laboratory analysis data. However, the HRA and CSM for the Hunter's Point Naval Shipyard identified the widespread use and site contamination resulting from the use and disposal (through sanitary and sewer lines) of Ra-226 at the site. In addition, in some parcels, some of the off-site laboratory results exceeded both the on-site laboratory results and the cleanup criteria and resulted in the need for additional excavation. Furthermore, several enforcement actions have confirmed that soil samples were swapped, so even if off-site data gave more precise and accurate results, those results may not represent the true levels of contamination at a given location. In addition, according to the Navy's radiological data evaluation reports, significant numbers of biased soil samples were collected from locations that avoided the areas with highest scan results, so they would not represent the true levels of contamination. Please revise the Draft Final Work Plan to remove or to modify footnote 3 to more accurately reflect the lack of data integrity obtained from both on-site and off-site laboratories during previous investigations.

    The footnote will be removed.

2. Section 3.2 (Radionuclides of Concern) Table 3-4, footnote b to Table 3-5, Soil Remediation Goals from Parcel G ROD and various other references throughout the Draft Final Work Plan include a list of the radionuclides ROCs that is inconsistent with the conceptual site model (CSM) in Section 2. The CSM in Section 2 lists Pu-239 as a ROC for Buildings 351A, 364, and 365, however Table 3-4 and footnote b of Table 3-5 list Pu-239 as a ROC for the Buildings 317/364/365 Site only. The HRA also indicates that Pu-239 is a ROC for Building 351A. In addition, the soil area entry in Table 3-4 that includes the Building 351A crawl space does not list Pu-239 as a ROC for this area. All references to buildings where Pu-239 is a ROC should be revised to provide consistent information. Please revise the Draft Final Work Plan to include Pu-239 as a ROC for Building 351A in all applicable sections.

The ROCs in Section 3.2, Table 3-4 will be updated as follows:

Table 3-4. Soil Radionuclides of Concern

Soil Area	Radionuclide of Concern
Former Sanitary Sewer and Storm Drain Lines	^{137}Cs, ^{226}Ra, ^{90}Sr
Former Buildings 317/364/365 Site	^{137}Cs, ^{226}Ra, ^{90}Sr, ^{239}Pu, ^{235}U
Building 351A Crawl Space	^{137}Cs, ^{226}Ra, ^{90}Sr, ^{239}Pu, ^{232}Th

3. Section 3.3.1 (Investigation Levels) states that the spectra will be evaluated using region of interest (ROI)-peak identification tools for the ROCs that correspond to gamma rays at 186 kiloelectron volts (keV) for Ra-226, and 609 for daughter Bismuth-214 (Bi-214). Please clarify how identifying the presence of Ra-226 near the RG without allowing for ingrowth of the daughter products Bi-214 and Lead-214 (Pb-214) and/or using the 186 keV energy line which is unreliable for quantifying Ra-226, will be sufficient for identifying Ra-226 in soil. Further, please list the investigation levels (ILs) for Ra-226 to clarify if the ILs will be significantly higher than the detection limits for scanning.

   The scan MDC calculation uses a Microshield model which assumes that the Ra-226 daughter products have been allowed to ingrow for a period of approximately 40 years. As noted in Section 3.3.1, ILs are typically equal to an upper estimate of the instrument- and material-specific background, such as the mean plus three standard deviations. ILs will be determined in the field and are not available to include in the work plan.

4. Section 3.4.6 (Former Building Site and Crawl Space Survey Unit Design) states that SUs 27 (peanut spill) and 28 (LWTS) at the Former Buildings 317/364/365 will be excavated to 2 and 10 feet below grade surface (bgs), respectively, and all other SUs will receive surface sampling only. For more clarity to the reader, the Draft Final Work Plan should explain why all SUs except for 27 and 28 will only receive surface sampling and will not be excavated.

   The text in Section 3.4.6 will be updated to read as follows (new text is underlined): "At the Former Buildings 317/364/365 Site, SUs 27 (peanut spill) and 28 (LWTS) will be excavated to 2 and 10 feet bgs, respectively, <u>for consistency with the previous excavation boundaries</u> (Figure 3-1)."

5. Footnote B to Table 8-1, Derived Air Concentrations, indicates Th-232 is not a ROC; therefore the Derived Air Concentration (DAC) for Pu-239 is the most restrictive. However according to the HRA, Th-232 is a ROC for Building 351A and former Building 408. Please revise the Draft Final Work Plan to require the Th-232 DAC to be the limiting standard for Building 351A.

   Footnote b about Th-232 will be removed, and the remaining footnotes will be revised to state the following:

   [a]**The most restrictive DAC for alpha-emitting nuclides is ^{232}Th. The most restrictive DAC for the ROCs in an area will be used.**

6. [b]**The most restrictive DAC for beta-emitting nuclides is ^{90}Sr. The most restrictive DAC for the ROCs in an area will be used.** The Appendix C Soil Reference Background Area Work Plan (Background WP), Section 2 (Purpose and Data Quality Objectives), Step 7, should be revised to explain how reference background areas (RBAs) will be determined to be suitable for use in the background analysis. This section states gamma scanning measurements will be performed within the RBAs to confirm the areas are free of elevated gamma levels and are suitable for sampling; for clarity for the reader, please explain how elevated gamma levels will be determined (e.g., three standard deviations from mean or another method). Additionally, please state whether specific alternative background sites have been identified for sampling in the event that one of the currently identified RBA sites is determined to be contaminated.

   Gamma scan data will be evaluated as described in Section 4.1 and a reference to the section will be added in Section 2 to the bullet describing Step 3 of the DQOs. Alternative RBAs have not been identified at this time.

7. In Appendix C Soil Reference Background Area Work Plan Section 4.1.1 (Conduct a Preliminary Data Review), please explain how the background data set distributions will be evaluated for statistical testing. This section states that radionuclide-specific (spectra) and gross gamma data set information will be gleaned by compiling basic statistics, including mean, median, minimum, maximum, and standard deviation, and by creating plots, such as histograms, box plots, and normal probability plots, from each RBA. Please also state whether the distribution of the data sets will be tested to determine whether they represent a normal distribution or exhibit skewness or other population distributions, and/or if non-parametric tests for calculating the mean and standard deviation will be used. Please revise this and any other relevant sections of the Draft Final Work Plan to include this information.

   Note that Section 4.1.1 applies to the evaluation of gamma scan data and the suggested revisions are not applicable. Section 4.2.1 includes the discussion of the evaluation of analytical data from the RBAs.

8. Appendix C Soil Reference Background Area Work Plan Sections 4.1.2 (Identify Outliers) and Section 4.2.2 (Identify Outliers) propose to conduct parametric outlier tests (i.e. Rosners' and Dixon's) for background data sets to identify population outliers; however, these tests assume data set normality and therefore may not be appropriate given the actual data distribution. In order to ensure the data evaluation is technically correct and defensible, please revise the Draft Final Work Plan to propose non-parametric outlier tests that are not dependent on the distribution of the data set.

   Testing and validations of the assumptions in a statistical test, such as the assumption of normality in the use of the referenced outlier tests, is part of the evaluation process. Distribution testing will be performed to confirm the appropriate statistical tests are being performed. Section 4.2.2 of the text states that non-parametric methods may be used.

9. Appendix C Soil Reference Background Area (RBA) Work Plan would be more clear if the text included additional explanation of the criteria for background soil sample collection and analysis. For example, Step 6 (Specify the Performance Criteria) states that RBA soil groups will be compared using the Kruskal-Wallis (KW) test and comparing data against different identified soil groups and against each RBA depth. Please explain in detail how this comparison will be used to establish background values. For example, please discuss the minimum number of

samples needed to specify a separate background profile per soil type. Further, responses to comments on the SAP indicate that background data sets will not be developed for different soil types. Please revise the Draft Final Work Plan, including Appendix C, to describe how distinct soil types will be identified, what the minimum requirements for establishing a separate background data set/profile for use in comparing such data to site samples. Alternatively, please define the term "soil groups." Additionally, please revise the Draft Final Work Plan to provide consistent information in the main sections of the Work Plan, the Appendix B SAP and the Background Work Plan that explains how the background analysis will be conducted.

Observed soil types will be recorded during the sampling process and will be reported. The site geologist will log the soil classification and lithologic characteristics for use in further evaluating RBA data. How the data are grouped (by Parcel, by soil type, etc.) will be a subject for discussion following the collection of data. The requested information regarding the planned process will be determined over the course of the study and subsequent data evaluation. The term "soil groups" was intended to be a general term describing different observed soil types and will be updated to "types".

10. Section 3.1.7 (Laboratory Analysis) indicates all uranium and thorium isotopes reportable by alpha spectroscopy will be analyzed and reported to determine if the radionuclide concentrations indicate the U-238 decay chain is in equilibrium. For consistency, please revise the Appendix C Section 4.2.4 to list U-234, U-235, and U-238, as well as Th-228, Th-230, and Th-232 isotopes as those that will be analyzed and reported by alpha spectroscopy for all RBA samples to ensure that sufficient evidence of the U-238 and Th-232 decay chain equilibrium conditions are provided.

    The last paragraph of Section 4.2.4 of Appendix C has been revised to read as follows (new text underlined): "Alpha spectroscopy will be performed for uranium isotopes (^{238}U, ^{235}U, ^{234}U), thorium isotopes (^{232}Th, ^{230}Th, and ^{228}Th), and ^{226}Ra." Additional text revisions are described in the response to comment 6 above.

DTSC Comments

1. DTSC provided general comments on the draft Work Plan and revised draft final in letters to the Navy dated March 26, 2018 and August 14, 2018, respectively. Additionally, follow-up comments were provided by email on October 19, 2018. Our comments have been addressed except for comment number eight of the August 14, 2018 letter. This comment has been partially addressed. The Work Plan indicates that Phase 2 of the fieldwork includes radiological surface scans. However, the language is not clear that the durable cover will be removed as was previously discussed with the Navy. Please clarify this in the Work Plan.

    Yes, the durable cover will be removed as part of the Phase 2 activities. The following sentence will be added to the work plan in the Executive Summary and Section 3.4: "For both Phase 1 TUs and Phase 2 TUs, the durable cover (including asphalt, asphalt base course, concrete, gravel, debris, or obstacles) will be removed to expose the target soils." In addition, the following sentence has been added to the second sub-bullet under Step 7 in Section 3.1: "<u>Prior to the survey, the durable cover (including asphalt, asphalt base course, concrete, gravel, debris, or obstacles) will be removed to expose the target soils.</u>"

2. The revised Work Plan Section 8.5 discusses air monitoring to be conducted at Parcel G. We understand that a site-specific air monitoring plan and associated Standard Operating Procedures (SOPs) are being prepared and will be submitted to the regulatory agencies for review.

   The air monitoring plan should adhere to the 2010 Basewide Dust Control Plan, which includes monitoring of COCs (total suspended particulates [TSP], arsenic, manganese, lead, particulate matter smaller than 10 microns in diameter [PM10], and asbestos) and radionuclides of concern (ROCs) to ensure worker and community safety.

   Due to the proximity of the new Parcel A residential units, we request the development of dust action levels based on a residential exposure scenario. The DTSC Human Health Risk Office (HERO) has previously prepared dust action levels for various cleanup sites. Upon request, we can provide you with a recent HERO dust action level memorandum. Please refer to DTSC Human Health Risk Office (HERO) Note 3 when developing COC dust action levels (https://dtsc.ca.qov/AssessinqRisk/upload/HHRA-Note-3-June-2018.pdf).

   Additionally, the primary objectives of air monitoring and sampling must be as follows:

   - Continual air monitoring during work activities to determine if airborne concentrations of particulate matter and COCs are more than action levels or regulatory limits established for the Site;
   - Develop a relationship between fugitive dust levels and concentrations of COCs, so that direct-reading particulate measurements can be used as a surrogate for COC concentrations in dust and, appropriate actions can be taken to reduce exceedances if necessary;
   - Develop a relationship between total Volatile Organic Compounds (VOCs) levels and concentrations of COCs, so that direct-reading total VOC measurements can be used as a surrogate for site VOC concentrations (if necessary); and
   - Ensure that engineering controls and work practices are effective to minimize potential off-site impacts.

   The air monitoring plan must be approved by the regulatory agencies prior to the start of the re-evaluation of the soil survey units' fieldwork at Parcel G.

   The soil investigation will be implemented by a separate contractor. A work plan addendum, containing an air monitoring plan will be provided by the Parcel G soil contractor prior to the start of soil handling operations and after this final work plan is issued.

CDPH Comments

<u>Previous SAP Comments</u>

1. EMB’s original Specific Comment #11 was not adequately addressed. This comment is one of a series of comments where EMB requested the removal of the word “allegation(s)” from any reference of Tetra-Tech E.C (TtEC) data manipulation due to the two guilty pleas and admission of falsified data. Sampling and Analysis (SAP) Worksheet #10 (“Conceptual Site Model”), Page 39, Paragraph two, Sentence one, still contains the word “allegation.”

The sentence referred to states "Following the investigation and removal actions, there were allegations that TtEC potentially manipulated and falsely represented data, and some allegations have since been confirmed." and is accurate as written.

2. EMB's Specific Comments #25, #26, and #27. All of these comments question minimal detectable concentration (MDC) discrepancies between off-site laboratory SOPs and stated project MDCs. Most notably, the comments stated project MDCs are well below laboratory SOP "typically" observed MDC values. SAP Worksheets #15 "A", "B", and "C" still list the project MDCs which are below the laboratory observed MDC values. Please explain.

   In Worksheet 15 of the draft final SAP, the laboratory MDCs for this project (listed in the last column of the tables) are below the project RGs (listed in the 3rd column of the tables). The laboratory SOPs listed in Worksheet 23 and provided in Attachment 3 of the SAP reflect standard method MDCs that are the default values if a project does not specify specific detection limits. This explanation is also included as footnote "g."

3. EMBs Specific Comment #39 addressed survey units (SUs) identified in previous final status surveys (2009 and 2010) that appear to be missing from the current work plan. The following SUs are still not addressed in the current document:

Building ID:	Unaddressed SU(s):
351A	Crawlspace "S", "R", and "U"
366	69 and 70
411	1

   For Building 351A, in the Executive Summary and in Worksheets 11, 14, and 17 of the Draft Final SAP, there is a footnote that states "…For the Building 351A Crawl Space, former SU R, SU S, and SU U overlap SU M, SU N, and SU O and will be investigated as SU M, SU N, and SU O."

   For Building 366, a note will be added to work plan Figure 4-4 and SAP Figure 11-7 to state, "SU 69 consists of the building exterior surfaces. SU 70 is a mezzanine level in the southwest corner of the building. If it can be safely accessed, it will be surveyed as a Class 1 SU." In addition, the following text will be added to the end of the first paragraph of Section 4.4.3.3 of the work plan: "…The building exterior (SU 69) is a Class 3 SU. <u>The mezzanine level in the southwest corner of the building is SU 70, which will be surveyed as a Class 1 SU if it can be safely accessed.</u>"

   For Building 411, Section 4.4.3.6 of the draft final work plan included text about SU 1, which states "The third floor and mezzanine are no longer accessible because of concerns about structural stability; therefore, the Class 3 SU 1 that was previously surveyed is not included in this investigation. Access points to that area will be included with surveys of adjacent SUs." This statement will be added as a note on work plan Figure 4-7 and SAP Figure 11-10.

4. EMB Specific Comment #40 recognized that all of the listed utilities clearance subcontractors were located in the Virginia, Maryland, and New Jersey areas and requested possible local

(California) subcontractors. No changes appear to have been made in the DRAFT FINAL to address this.

The referenced SOP is general, and will be removed. The procurement of a local subcontractor is pending.

New Specific Comments

5. Section 3, Table 3.2, "Phase 2 Soil Trench Units": This Table does not include a sum for column 4, "Number of Samples in Original Trench Material". The sum for column 4 is 548 soil samples. Please correct.

   The total number of samples shown at the bottom of Table 3-2 in the draft final work plan represents the total number of samples from borings in original TU material plus the number of samples from sidewall/bottom borings. Subtotals for the number of samples from borings in original TU material and the number of samples from sidewall/bottom borings will be added to the table.

6. Section 3.54.6, Former Building Site and Crawl Space Unit Design. page 3-10, paragraph four, sentence one: At the former Building Sites: SU 27 (peanut spill) and SU 28 ((LWTS) will be excavated to 2 and 10 feet bgs, respectively (Figure 3-1)."Please make clear in the text that these excavations will also receive MARSSIM based soil sampling/surveys. Additionally, please clarify if the crawl space below the building 351A will be excavated prior to MARSSIM based soil sampling/surveys.

   The text in Section 3.4.6 will be updated to read as follows (new text is underlined): "At the Former Buildings 317/364/365 Site, SUs 27 (peanut spill) and 28 (LWTS) will be excavated to 2 and 10 feet bgs, respectively, for consistency with the previous excavation boundaries (Figure 3-1)." The excavations will receive MARSSIM based soil sampling/surveys. The Building 351A crawl space is not planned for excavation prior to soil sampling/surveys.

7. Section 4.4.1.2, Static Measurements. page 4-4. paragraph three, sentence one: The number of systematic measurements performed will be based on the guidance described in MARSSIM Sections 5.5.2.2 and 5.2.2.5 (USEPA et al., 2000) using the unity rule as the example basis for calculating the minimum static measurement frequency." It is noted that the unity rule is discussed in MARSSIM Section 4.3.3, "Use of DCGLs for Sites with Multiple Radionuclides". MARSSIM Section 5.2.2.5 is titled, "Determining Survey Location", and does not address the use of the unity rule in determining number of static sample locations. Please provide citation(s) for use of the unity rule in determining number of static sample locations. Please provide example equation for the use of the unity rule in determining number of static sample insert.

   The reference to MARSSIM Section 5.5.2.5 in the referenced text is in error and will be removed from the text as follows: "The number of systematic static measurements performed will be based on the guidance described in MARSSIM Section~~s~~ 5.5.2.2 ~~and 5.5.2.5~~ (USEPA et al., 2000)…". As noted in the referenced text, the use of the unity rule is an example to show the calculation to determine the number of required samples. The values described in the calculation are all multiples of the DCGLw. The use of unity allows the variables to be more clearly expressed in the absence of site specific data to evaluate – i.e., the DCGLw equals one, the standard deviation is equal to 25% of the DCGLw, or 0.25. Survey gross alpha or gross beta measurement data will be corrected for a material-specific background and compared to the

worst-case alpha or beta RG applicable to the building. The unity rule will not be used in evaluation of survey data against the RGs.